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CONTENTS.

EDITORIAL:
The Second Law of Thermodynamics..... 349
The Life of Electrical Machinery..... 349
The Rotating Sector-Disc Photometer..... 350
Progress in Electrification..... 351
Progress Toward an Ideal..... 351
The Second Law of Thermodynamics—Its Basis in Intuition and Common Sense, by Dr. William S. Franklin..... 352
The Present Status of the Electrification of the New York Zone of the New York Central & Hudson River Railroad, by W. J. Wilgus.... 354
The Field of a National Engineering Society, by Calvin W. Rice..... 358
The Single-Phase System in Steam Line Electrification and Electric Railway Development, by Calvert Townley..... 360
Problems in the Chemistry of Rubber..... 361
Improving the Italian Telephone Systems..... 362
The Railway Signal Association..... 362
Improvements in the Tantalum Lamp..... 362
LETTERS TO THE EDITOR..... 363
A Unique Electric Motor Installation..... 363
Recent Advances in Steam Turbines—Land and Marine..... 363
Discovery of the Mariner's Compass..... 364
The Electrical Discharge in Air and Its Commercial Application..... 364
The Sons of Jove..... 364
The Benefit of Enquiry to Lightning-Arrester Practice, by N. J. Neall. 365
Electric Power from Southern Waterfalls, by J. W. Fraser..... 367
Small Railway Substations, by W. L. Waters..... 372
Report of the British Association Committee on Practical Standards for Electrical Measurement..... 375
Fuel, Water and Gas Analysis for Steam Users, by John B. C. Kershaw. 376
The Sao Paulo Tramway, Light and Power Company, by F. M. Feiker.. 378
The Telephone Situation in Chicago, by a Staff Correspondent..... 381
The Liberal Education..... 383
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE..... 384
METHODS OF GETTING NEW BUSINESS—"Organization and Conduct of a New-Business Department Suitable for Central Stations in Cities of 50,000 Population and Under," by J. M. Robb (Concluded)..... 386
INDUSTRIAL SECTION:
Single-Phase Induction Motors..... 388
New Generators for the Ottumwa Railway and Light Company... 389
Enlargement of Equipment of the Locke Insulator Manufacturing Company, Victor, N. Y..... 389
Meeting of the Sales Managers and Representatives of the Buckeye Electric Company..... 389
Meeting of the Shelby Electric Salesmen's Association..... 390
The Gleason Universal Moulding Box..... 390
The "Star" Toggle Bolt..... 391
Eureka Electric Flat-Irons..... 391
Weatherproof Incandescent Lamps..... 391
Adjustable Incandescent Lamp Fixtures..... 392
New Type Midget Plug and Receptacle..... 392
The Buckeye Two-Cycle, Single-Acting Gas Engine for Generator Driving..... 392
National Air-Compressors..... 394
CURRENT ELECTRICAL NEWS..... 396
Directory of Electrical and Allied Engineering and Scientific Societies.. 401
Record of Patents Issued..... 402

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THE SECOND LAW OF THERMODYNAMICS.

One of the fundamental laws of physics, and yet one which is very frequently misunderstood, is that known as the second law of thermodynamics, the law which states the maximum possible efficiency of a process involving the transfer of heat. This law is encountered in nearly all of our dealings with energy, and the engineer should have not only a complete grasp of its meaning when expressed in mathematical symbols, but it should become second nature with him, so that he recognizes it in all his dealings with nature. Something of this sort of feeling does exist, although it is not generally recognized as a law of thermodynamics. This idea is enlarged upon in a most interesting paper appearing on another page of this issue by Dr. W. S. Franklin, professor of physics at Lehigh University, who contends that the law has a basis in intuition; that we recognize its application unconsciously; and he drives his arguments home with apt quotations from old, but honored, sayings. No one who reads this article can fail to get a better understanding of what the law implies and how wide is its application.

THE LIFE OF ELECTRICAL MACHINERY.

A good deal has been said recently about the rapidity with which electrical machinery becomes antiquated and the readiness with which machinery only a few years old is thrown out, to be replaced by more recent designs. It has been said that the generation of electrical machinery is, at the most, three or four years, and that at the end of this time it should be replaced by new.

Such statements probably lead many to believe that electrical apparatus is delicate, and that a few years' service render it unsuitable for further use; otherwise, why should it be thrown out after such a short time? This, of course, is an incorrect view, for machinery which becomes useless after but three years' service could not give that reliability in service which is necessary. Should one who is not informed make some enquiry into the matter, he would probably be told that the changes are made, not because the old machinery is worn out, but because the new machinery is so much better that it may be purchased and the old thrown away, and yet the difference in the returns to the station show that the change has been profitable. Such an incomplete explanation would naturally lead to the idea that the old machinery was very poor and inefficient. Here again the conclusions would be at variance with the facts.

To illustrate the fact that, although a generation in electrical machinery may be brief, this does not mean that the life of any particular machine is short, a report recently made by Sir William Preece respecting the equipment of the Bristol,

England, municipal power station may be mentioned. While this station was put in service in 1893, it contains a good deal of modern machinery, including a number of steam-turbine-driven alternators. Enlargements and changes becoming desirable, and the plant being a municipal one, it was necessary that all items of cost should be carefully examined. Sir William was asked to prepare a statement showing the probable life of all parts of the equipment if properly maintained, also the value at the end of this life. In his report he states as his opinion that the life of the dynamos and alternators is thirty years, and the residual value eight per cent. The life of the armored cables is thirty-five years, with a residual value of fifteen per cent. The life of motors is put at twenty-five years, and their value at the end of that time at nine per cent. Compare these figures with the similar ones for other parts of the equipment. The water-tube boilers, for example, are given a life of twenty-five years and a residual value of five per cent. The engines and other machinery are given twenty-five years and a residual value of six per cent. It is evident that, according to this report, the electrical machinery has a longer useful life than have other moving mechanisms, and this is to be expected if one considers the character of the work performed.

A few other figures from this report may be interesting. Storage batteries, for example, are given a life of fifteen years, with a residual value of ten per cent—figures which will, doubtless, be surprising to many. Arc lamps are expected to last twelve years, and lamp-posts forty years. Meters and accessory instruments of a similar kind are given twelve years.

Such figures certainly do not agree with the idea of delicate mechanisms; so the question may properly be asked, why should the old equipment be thrown out? The answer is, of course, as mentioned above, to increase the efficiency of the station. But electrical machines are probably the most efficient mechanisms, taken as a class, that man has yet constructed, and a change of a fraction of a per cent would hardly seem to warrant wholesale condemnation and vast expenditure.

The explanation is the correct one, but it does not go far enough. The fact is that while the new electrical machinery is more efficient than the old—and this is to be expected with our growing experience—it is in other parts of the equipment that the gain is made. The enormous new generators now becoming standard are not so very much better than the older machines, but they make possible the use of more efficient engines, the doing away with wasteful appliances, and the operation of the station in such a way as to obtain better results. It is not simply because the 5,000-kilowatt generator is some per cent more efficient than the 500-kilowatt machine that it is being adopted and the other thrown out, but it is because, with this size of unit, the station as a whole is much improved and economies are effected which would otherwise be unobtainable. In other words, while electrical machinery is highly efficient and may be run satisfactorily as long as other classes of machinery, advances in electrical design have made possible such improvements throughout the entire plant that it becomes profitable to change from the old to the new.

THE ROTATING SECTOR-DISC PHOTOMETER.

Accurate work with the photometer is not as easy as the uninitiated would suppose. It requires a considerable degree of skill, and is trying work. Any new method of making photometric comparisons which brings increased accuracy or relieves the operator of some of the strain is valuable. There are so many precautions to be observed, such as protecting the operator, as well as the photometer itself, from stray light, and distinguishing between a difference in intensity of illumination and a difference in tint, and the fact that the final comparison must depend upon the eye, that any new method must be scrutinized carefully and put to very severe tests before it should be adopted.

One of the methods which is used to some extent depends upon reducing the intensity of illumination of one of the surfaces observed by means of a rotating disc cut in such a way as to enable the amount of light which falls upon the surface to be varied at will. This device is not new, but its accuracy has been questioned. It possesses some advantage, since, when used, there is no need to move either of the two sources of light which are compared. Their position is then always known exactly. But the physiological effect upon the eye would seem at first thought to be a more or less complicated function of the amount of light falling upon the retina, so that actual proof must be given before we can accept the principle that a certain intensity of illumination acting continuously produces the same effect as one of double the intensity, but which is allowed to act upon the eye intermittently but half the time, even though the interruptions come so rapidly that the eye does not perceive them. If, on the other hand, it can be demonstrated experimentally that the actions produce the same stimulation, it would seem to establish a law of simple relations. This effect is the so-called Talbot law, which was enunciated in 1835. Talbot himself recognized that a physical law could not be applied to physiological phenomena, but his law was based upon experimental evidence. Since his time many have investigated the law, some finding that it holds with fair accuracy, and others not finding satisfactory agreement; and while the apparatus has continued in use, the question raised regarding its reliability has never been satisfactorily answered. To clear up the uncertainty thus surrounding a useful photometric instrument, Mr. E. P. Hyde has recently carried out a very careful and somewhat elaborate investigation, and he gives his results in the bulletin of the Bureau of Standards, Washington, D. C., for June.

In making these comparisons, since a high degree of accuracy is sought, certain assumptions usually made in photometric measurements were not allowable. For example, the law of inverse squares, which is universally adopted—at least, in all commercial measurements—could not be employed when using a source of light the luminous surface of which was not fairly well concentrated at a point. For this reason incandescent lamps of the usual types were not available, because of the length of the filament, although, in other ways, they are most satisfactory. With such lamps there is also a possibility of error due to the images formed by reflections from the bulb. Mr. Hyde therefore substituted for the incandescent lamp the Nernst lamp, and inves-

tigated the deviation from the inverse square law which would follow when a cylindrical luminous surface such as is presented by the glower was employed. The investigation showed that if the radiating cylinder had infinite length, the intensity of the action varied inversely with the distance, agreeing with a well-known law in electromagnetism. For ordinary distances, however, and for lengths of glower such as were used, the deviations from the inverse square law were entirely negligible. Certain precautions were found necessary when using the glower, particularly the method adopted for protecting it from draughts of air, which caused changes in temperature.

Mr. Hyde found that the deviation from Talbot's law varied with the angular opening of the disc in degrees. When the opening was 180 degrees there was perfect agreement with the law. With an opening greater than this there was an apparently slight deviation from it, amounting in the worst case to an error of 0.2 per cent. With smaller openings the error was in the other direction, amounting to about 0.4 per cent when the opening was but forty degrees.

A closer examination of the conditions of the experiment suggested to the investigator that some of the discrepancy might be due to a congested condition of the apparatus at those times, and to the deviation of the glower in the inverse square law; but the error under the excellent conditions of the experiment was surprisingly small. Experiments made with colored lights also gave approximate agreement with the law, but the error of observation was in these cases somewhat greater; and when lights of different color were employed on the two sides of the screen, the same satisfactory agreement was obtained. The author concludes that Talbot's law, in its application to a rotating sector disc, is verified for white light for all total angular openings between 288 degrees and ten degrees, to within a possible error of 0.3 per cent, which represents probably the limit of accuracy of the experiment. The deviations from the law for red, green and blue light are of the same order of magnitude as those for white light. Moreover, a difference in color on the two sides of the photometer screen produces no appreciable change in the observed deviation from the law. The last word is thus in favor of the rotating sector disc, and this convenient piece of apparatus may now be used with confidence.

PROGRESS IN ELECTRIFICATION.

Somehow or other, when one speaks of "electrification" to-day the idea conveyed is the substitution of electric motors for the steam locomotive on railways. Why this one adaptation should have appropriated to itself the term can not be explained, though it probably has something to do with the interest which the public has in all matters relating to railway improvement. Whatever may be the explanation of the limitations imposed upon this term, there can be no question regarding the great interest of all in the work itself, and for this reason all will read with pleasure the two articles on this subject appearing in this issue of the ELECTRICAL REVIEW. The one by Mr. W. J. Wilgus describes the progress which has been made by the New York Central & Hudson River Railroad in the enormous change which is being carried out on its New York section. This is, undoubtedly, one of the most magnificent pieces of engineering work that is being done in the world to-day.

The second article is by Mr. Calvert Townley, and it deals with the possibilities of the single-phase system, which has been adopted by the New York, New Haven & Hartford Railroad, the conversion of which to electric traction is also one of the big transformations now going on.

Mr. Townley is a firm believer in the single-phase system, but his arguments are not merely an advocacy of that system. They deal with the larger problems of electrification; the advantages to be secured by the adoption of the motive power, irrespective of the particular system employed. The arguments in favor of electrification most frequently heard are that it will reduce the expense of operation and will give a cleaner and more frequent service. These, however, are not the real reasons for adopting the new system; in fact, an increase in operating expense may follow electrification, and yet the transformation be most satisfactory from a commercial point of view. The real advantages lie in the fact that the capacity of the road, and therefore its earning power, may thereby be greatly increased. More cars may be run, more passengers and more freight handled without necessitating a reconstruction of the roadbed. This is an argument which will appeal to those who are called upon to furnish capital for carrying out the transformation.

PROGRESS TOWARD AN IDEAL.

From time to time every journal which keeps pace with the growth of the industry to which it is devoted finds that certain changes become desirable, if it is to present to its readers the information they seek in a form at once the most complete, the most instructive and the most attractive. To this end it becomes imperative to adopt those improvements in the arts of printing and of illustrating which are continually being made.

Again one of these periods has come to the ELECTRICAL REVIEW, and those changes and enlargements which make this journal better and more representative of the great electrical industry are made in this issue. Attention is called to them with the confidence that they will meet with approval and that this issue will receive the commendation of all readers as an example of a well-balanced journal. To emphasize these changes, a number of unusually valuable and interesting papers have been contributed by men eminent in the various branches of electrical engineering.

In carrying out these improvements the old ideals set forth in the first issue have not been lost sight of: "To keep our readers informed as to the most important and valuable inventions pertaining to these subjects, giving suitable illustrations of new objects and discursive reviews of the same, is the principal purpose of this journal." But it is believed that the ELECTRICAL REVIEW in its present form more nearly represents these ideals as they are held to-day.

The Second Law of Thermodynamics; Its Basis in Intuition and Common Sense.[1]

By William S. Franklin, Sc.D., Professor of Physics in Lehigh University.

IT is the object of this article to give a simple account of that fundamental principle in physics which is known as the second law of thermodynamics. This law ranks with the principle of the conservation of energy, and the two are, perhaps, the most important of the generalizations of modern physical science. Some adequate sense of the meaning of both must sooner or later become ingrained in the intuitive consciousness of all men; indeed, most men have already an intuitive sense of the second law of thermodynamics of no mean order, and it is the purpose of this article to give a sharp characterization to this widely diffused intuition.

Every one has a feeling of the irretrievable effects of disaster. The collapse of a bridge, the destruction of a house by fire, or the wreck of a ship, these things involve losses which indeed may be forgotten after reconstruction, but never balanced. The havoc that is wrought is essentially irreparable.

It is desirable to use the word degeneration in a very narrow technical sense later when we come to consider the second law of thermodynamics, and the way may be paved to a clear understanding of the later and accepted use of this word in physics by applying it now to designate that aspect of disaster which is irreparable. We may speak, for example, of the degeneration of any structure from a state of coordinated perfection to a cataclysm of chaos, and this degeneration is essentially irreparable, or it can be repaired only at a certain cost.

It is very important, however, to avoid the carrying over of this idea of structural degeneration to thermodynamics, where a much more limited conception of degeneration arises. The term thermodynamic degeneration applies to the effects of turbulence, in the changing of a gas from high to low pressure, in the equalization of temperature in a pail of water when a hot stone is dropped into it, and so on.

Before passing on to the consideration of that kind of degeneration which accompanies turbulence, thermodynamic degeneration, as it is called, it is important to consider the extent to which the laws of mechanics, including the laws of equilibrium and acceleration, and the law of action and reaction, are inapplicable to the infinitely complicated phenomena that accompany turbulence in physical systems.

The laws of motion! Every one has to some extent a feeling of the absurdity of the idea of reducing the more complicated phenomena of nature to any orderly system of mechanical law. For, to speak of motion is to call to every one's mind first of all the phenomena that are associated with the excessively complicated, incessantly changing, turbulent and tumbling motion of wind and water. These phenomena have always had the most insistent appeal to us; they have confronted us everywhere and always, and life is an unending contest with their fortuitous diversity, which rises only too often to destructive sweeps of destruction in fire and flood and in calamitous crash of collision and collapse where all things commingle in one dread fluid confusion. The laws of motion! Be assured that the science of mechanics is circumscribed in utter repudiation of such universal phrase.

Before attempting to define the limits of mechanics, which we must do if we are to define the limits of thermodynamics, for most of present-day physical science falls under the one or other of these two heads, let us consider a very general application of the simplest idea of motion, the idea of velocity. Every one has an understanding of what is meant by the velocity of the wind, and a sailor having what he calls a ten-knot wind knows that he can manage his boat with a certain spread of canvas and that he can accomplish a certain portion of his journey in a given time; but an experienced sailor, although he speaks glibly of a ten-knot wind, belies his speech by taking wise precaution against every conceivable emergency. He knows that a ten-knot wind is by no means a sure or simple thing, with its incessant blasts and whirls, and a sensitive anemometer, having much more regard for minutiæ than any sailor, usually registers in every wind a number of almost complete but excessively irregular stops and starts every minute and changes of direction that sweep around half the horizon.

Surely the science of mechanics, using the term in its broad sense, which includes hydraulics and pneumatics, can not extend in its strict application to such fitful phenomena as those presented by the wind. In fact, the science of mechanics, except in its vaguely general aspects, as exemplified by the above application of the idea of velocity to the wind, is limited to the more or less ideal phenomena which are associated with the motion of rigid bodies, either singly or in connected systems, with systematic motion of distortion of elastic bodies, and with ideally simple motion of flow of liquids and gases. When we consider actual motion, however, we always encounter turbulence more or less marked, and the science of mechanics, which is the science of describing the phenomena of motion, fails utterly if we insist upon taking account of the minute details of the phenomena of motion which are involved in this turbulence.

Let one, for example, watch the movement of the water at a certain point in a brook. There is indeed a fairly steady average velocity of the water at the point and a certain mean rhythmic variation, but superposed upon this average motion there is an erratic variation of velocity that is infinitely manifold, the details of which are beyond the scope of any descriptive science, a descriptive science being a science like mechanics, which is concerned with how things progress as a phenomenon develops itself, how the structural members of a bridge stretch and shorten as a car passes across the bridge, how pressure and temperature of steam vary during the successive stages of admission, expansion and exhaust of a steam engine; how electromotive force, current strength, electromagnetic force and all of the changing variables play in the operation of a dynamo. But who could recite the story of the most minute details of these phenomena? It can not be done, and if it could be done it would be of no avail, for these details can never be twice alike, and the very essence and value of a science lies in the discovery of types which in their important features recur so that a knowledge of these types can serve as a basis for anticipation and design.

The important thing in connection with the turbulent aspect of a physical phenomenon is its general result or consequence, just as the important thing about the burning of a house is the loss. How utterly useless and uninteresting it would be, for example, to study the minutest de-

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tails of a conflagration, assuming such a study to be possible, recording height and breadth and the irregular and evanescent distribution of temperature throughout each flicker of consuming flame, the story of each crackling sound, and every yield and sway of timber and wall.

The fact is that we are immersed in an illimitable sea of phenomena, every single detail of which is itself infinitely manifold, and no completely adequate descriptive science can ever be developed. One fundamental fault in modern meteorology, for example, lies in the complete domination of nearly all meteorologists by the methods and ideas of the so-called exact sciences, exact because they refer very largely to ideal phenomena and ignore minutiæ.

Physical science, then, consists of three main branches: (1) mechanics, including hydraulics, electricity and magnetism, light and sound; the science of those phenomena in which turbulence may be for practical purposes ignored; (2) statistical physics, the science of those phenomena in which turbulence introduces an appreciable and practically important erratic element; meteorology is the best example of statistical physics, although any phenomenon whatever has its statistical aspect; and (3) thermodynamics, and in order to explain the essential characteristics of thermodynamics it is needful to draw a parallel. In every-day life we see the fire insurance companies concerned with certain broad features of statistical physics in their examination and records of fires, and we see them also concerned with a profit-and-loss account which is wholly abstracted from the details of the phenomena of conflagration. Thermodynamics is the profit-and-loss branch of physics, as it were, and, like the profit-and-loss branch of fire insurance, thermodynamics, properly speaking, is completely and absolutely abstracted from any consideration of the details of any physical phenomenon. Thermodynamics is concerned with the measurement and accounting of that type of physical degeneration which accompanies turbulence, just as fire insurance is concerned with the estimation and accounting of what we might call, using a fine phrase, structural degeneration by fire.

A turbulent process[1] in a physical system always plays a certain havoc, or effects a certain degeneration of the system. Thus a certain degeneration is associated with the escape of a compressed gas through an orifice, a certain degeneration is associated with the flow of heat from a region of high temperature to a region of low temperature, a certain degeneration is associated with the conversion of work into heat by rubbing a coin on a board, and so on.

The numerical measure of thermodynamic degeneration is called entropy.[1]

THE SECOND LAW OF THERMODYNAMICS.

(*a*) *The thermodynamic degeneration which accompanies a turbulent process can not be directly repaired, nor can it be repaired by any means without compensation.*

This is an entirely general statement of the second law of thermodynamics. The direct repair of the degeneration due to a turbulent process means the undoing of the havoc wrought by the turbulence by allowing the turbulent process to perform itself backwards, an idea which is exactly as absurd as the idea of allowing a burned house to unburn itself, or as the idea of the man in our town who was so wondrous wise, and who after scratching out both his eyes, just scratched them in again!

Following are several specialized statements of the second law of thermodynamics:

(*b*) *Heat can not pass directly from a cold body to a hot body, nor can heat be transferred from a cold body to a hot body by any means without compensation.*

(*c*) *Heat can not be converted directly into work nor can heat be converted into work by any means without compensation.*

The direct conversion of heat into work would be the simple reverse of any of the ordinary turbulent processes which involve the degeneration of work into heat. For example, work is degenerated into heat in the bearing of a rotating shaft, and we all know that to reverse the motion of the shaft will not cause the bearing to grow cold and the heat so lost to appear as work and drive the shaft! That would be a rotary engine indeed! There is an important general theorem in thermodynamics to the effect that if two turbulent processes, A and B, involve the same amount of degeneration, and if either of the processes, say A, has been allowed to perform its sweep, then, by a lever arrangement, as it were, the process B can be let down gingerly and the havoc wrought by the sweep of A can be undone, leaving the system B, however, in the condition into which it would be degenerated if the process B had been allowed to sweep instead of being let down gingerly. This is very much as if, having two exactly similar houses, A and B, one of which, A, has burned, we could rig up a mechanism which would reduce B imperceptibly to ashes and thus cause A to be restored, and *vice versa*. This general theorem is as thoroughly established as any generalization in physics, and if it is true, and if we ever find a way to convert heat into work unconditionally and without cost or compensation, then it will be proven indirectly that a shaft *can* be driven by heating one of the journals in which it rotates, for direct conversion of heat into work by one process must be, according to this general theorem, equivalent and replaceable by the reverse of any ordinary process which converts work into heat.

(*d*) *A gas can not pass directly from a region of low pressure to a region of high pressure, nor can a gas be transferred from a region of low pressure to a region of high pressure by any means without compensation.*

Fancy a gas squirting itself backwards, through a nozzle into a high-pressure reservoir! The repeated statement of self-evident facts concerning direct repair in these statements of the second law of thermodynamics may seem ridiculous to the intelligent reader, but it must be remembered that few people realize that the second law of thermodynamics is a statement of a fact which every one knows coupled with a generalizing clause which once thoroughly understood is almost if not quite self-evident. Here is one more statement of the second law, the oldest English version of it:

Humpty Dumpty sat on a wall,
Humpty Dumpty had a great fall.
All the king's horses and all the king's men
Can not put Humpty Dumpty together again.

This is perhaps the most dignified of all the statements of the second law, for which we will allow it to pass for the moment, inasmuch as it omits all nonsense about direct repair and refers at once to external means.

It is of the utmost importance, however, to remember in Humpty Dumpty's case that we are concerned with structural degeneration; or, if Humpty Dumpty was ever really alive, with a much more elusive and irreparable kind of degeneration which defies all external means, compensated or not compensated; but let us return to the fourth statement (*d*) of the second law and consider by means of an example what is meant by compensation in its thermodynamic sense.

A gas can be transferred from a region

[1] It is undesirable here to go into a full discussion of the three types of physical action which produce thermodynamic degeneration. See an article in *Science*, November 20, 1903, and see chapter on thermodynamics in Nichols and Franklin's "Elements of Physics," vol. i.

[1] It is not desirable here to outline the argument which establishes the idea of entropy and fixes its use as a numerical measure of thermodynamic degeneration. See *Science*, and Nichols and Franklin, *loc. cit.*

of low pressure to a region of high pressure by means of a pump, and the work that is done in driving the pump, even supposing the pump to be frictionless, is all converted into heat. This conversion of work into heat, which is a degeneration, is the necessary cost of or compensation for the transfer of a gas from a low-pressure region to a high-pressure region, which transfer is what might be properly called a regenerative process.

Considering the second statement (*b*) of the second law, we know that in an artificial-ice factory heat is continually abstracted from the freezing room and transferred to the warm outside air, but in order to accomplish this, even by an ideally perfect and frictionless mechanism, a certain amount of work must be allowed to degenerate into heat so that the amount of heat that is delivered to the warm air outside exceeds the heat that is abstracted from the cold room by the amount of heat that has resulted from the conversion into heat of the work spent in driving the refrigerating machine.

Considering the third statement (*c*) of the second law, we know that in an ordinary steam engine heat is converted into work, but in order to accomplish this transformation a large quantity of heat must be supplied to the engine at high temperature, and some of this heat (about nine-tenths of it in the very best engines) must be let down, as it were, to the low temperature of the exhaust to compensate for the conversion of the remainder into work.

The Present Status of the Electrification of the New York Zone of the New York Central & Hudson River Railroad.

By W. J. Wilgus, Vice-President of the New York Central & Hudson River Railroad.

THE change of motive power from steam to electricity on the New York Central & Hudson River Railroad involves a number of problems of almost as much interest and importance as the substitution of electricity for steam as a motive power. The departure from steam practice of seventy years' growth brings with it the necessity for many other changes from existing methods of handling traffic. The use of electricity naturally carries with it a much more frequent train service, which necessitates the elimination of all track, street and highway grade crossings, radical changes in passenger station facilties, increase in the number of main tracks for handling a larger number of high and low-speed units, the substitution of automatic for controlled manual signals, and many other improvements that are necessary for handling an increased electrically propelled traffic with safety, convenience and reliability.

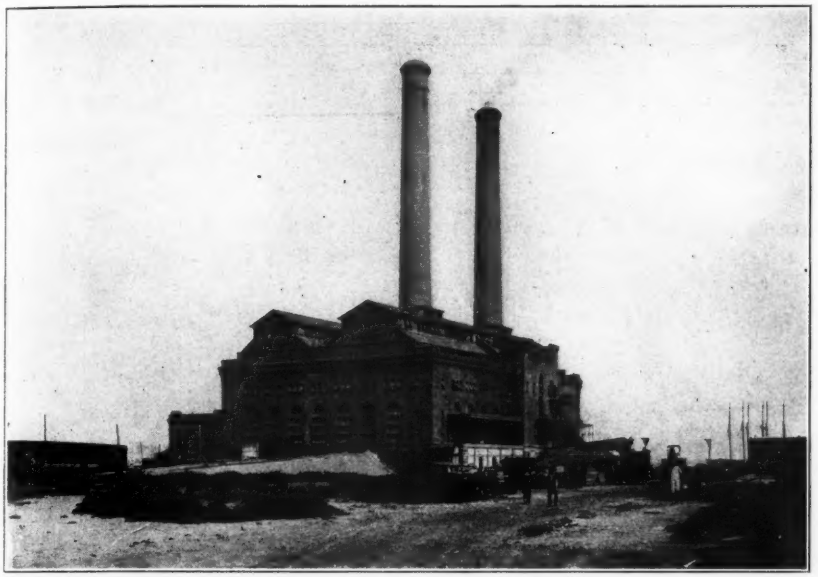
The agreement between the city of New York and the railroad company calls for the substitution of electricity for steam through the Park avenue tunnel only, but the railroad company, from a broad standpoint, concluded that the benefits of electric traction should be extended to embrace not only the remainder of its passenger lines in New York city lying northerly of the Park avenue tunnel, but also extending out into Westchester county for a distance of from twenty-five to thirty miles from the Grand Central terminal. In reaching this conclusion it was also decided that the ordinary principles of humanity must be observed in carrying on, simultaneously with the change of motive power, the elimination of grade crossing through the cities and towns. In almost every instance the local communities cooperated with this policy, but regardless of the strenuous efforts of all concerned the proposed improvements north of the limits of Greater New York are at a standstill because of the lack of approval of the plans for the elimination of grade crossings by the board of railroad commissioners as provided by law.

Consequently the railroad company is forced to temporarily terminate the northerly limits of its electric zone at High Bridge on the Hudson division and Wakefield on the Harlem division, seven miles and thirteen miles, respectively, from the Grand Central terminal. The extension of the electrical service northerly from those points to the ultimate termini at Croton or Peekskill on the Hudson division and North White Plains on the Harlem division is dependent upon the action of the state officials in approving the elimination of grade crossings.

GRAND CENTRAL TERMINAL IMPROVEMENT.—THIRD RAIL AND PIPE LINE. 1 AND 4—THIRD RAIL ERECTED COMPLETE. 2 THIRD RAIL ERECTED WITHOUT COVERING. 3—THIRD-RAIL BRACKETS ERECTED.

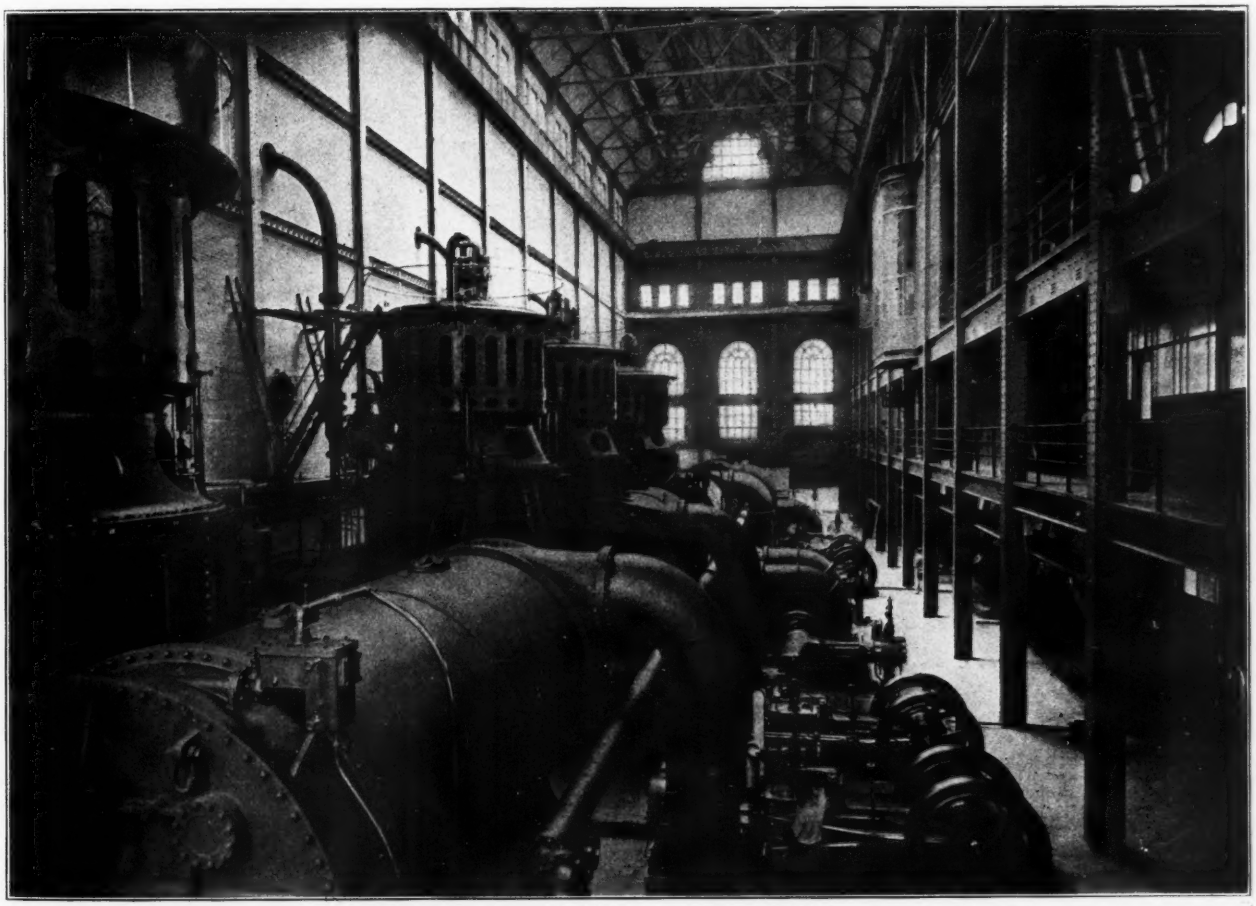
The work incident to the change of motive power in the initial electric zone south of High Bridge and Wakefield is progressing rapidly, and, so far as motive power is concerned, everything will be in readiness for the change in the latter part of September or the early part of October. The inability, however, to complete the new automatic block signals and all-electric interlocking at that time, coupled with the

abnormal rush of passenger business in September and October, makes desirable the fixing of the final date for the change of motive power from steam to electricity in the latter part of October or the early part of November.



PORT MORRIS POWER STATION, LOOKING NORTHEAST.

In order that the change of motive power may be made prior to the final completion of the enlarged Grand Central terminal, the portion of the new terminal adjacent to Lexington avenue, between Forty-fourth and Fiftieth streets, and also on the east side of Park avenue between Fiftieth and Fifty-seventh streets, is rapidly approaching completion and will be temporarily equipped to act as an electric suburban terminal. The westerly side of the existing steam terminal will be electrified so that the through trains hauled by electric locomotives may be accommodated therein. This procedure will permit the abandonment of the easterly side of the existing steam terminal, the site of which will then be excavated and the permanent work constructed, so that the Lexington avenue terminal may be extended westerly sufficiently to accommodate all business, both suburban and through trains. The westerly existing terminal will then be abandoned, the site excavated and the new permanent terminal completed. The first step, as above described, will be in readiness for the change of motive power in the fall; the second step will follow about a year later, and the final completion of the terminal is expected to take place in 1910. It is, of course, self-evident that this gradual process of construction is necessary in order to avoid interference with the exceedingly large regular passenger traffic



PORT MORRIS POWER-HOUSE—TURBINE ROOM, LOOKING WEST.

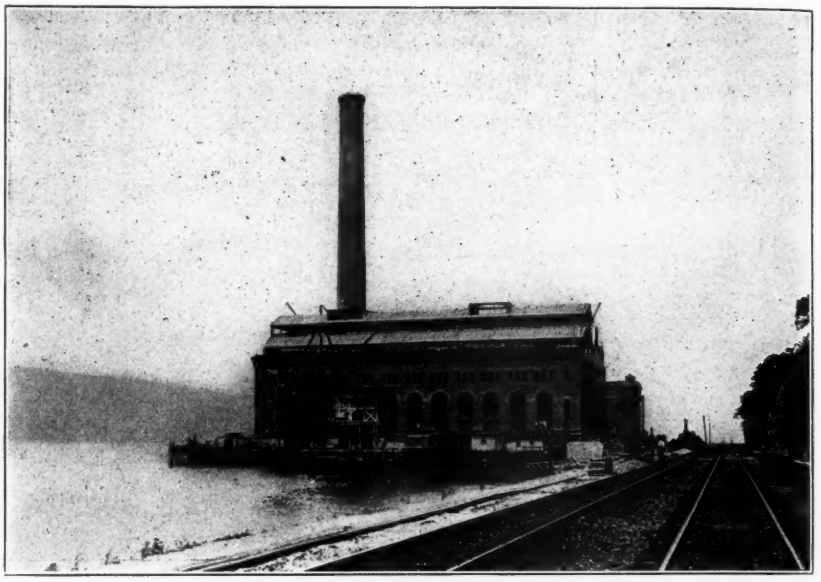
of the railroad companies using the Grand Central terminal at the same time that the new double-storied station, yard and street viaducts are being constructed.

In addition to the Grand Central terminal, work is about to be started on the new Bronx station improvement at Mott Haven, which will involve the building of an overhead station spanning eight main tracks and the elimination of all grade track crossing at the junction of the four-track Hudson division and the four-track Harlem division with the four-track trunk line between Mott Haven and the Grand Central station.

New commodious overhead stations are also about completed at High Bridge, Morris Heights and University Heights on the Hudson division, and minor station changes are also under way at other points within the initial electric zone to harmonize with the change of motive power and reversal in direction of traffic.

In order to properly provide for the change of motive power from steam to electricity, and *vice versa,* elaborate temporary engine terminals are about completed at High Bridge and Wakefield. At these places engine-house facilities have been provided for the steam locomotives and inspection sheds and pits for the electric locomotives. At Croton and North White Plains extensive permanent shops are under construction for the inspection and repairs of electric motor-cars and electric locomotives.

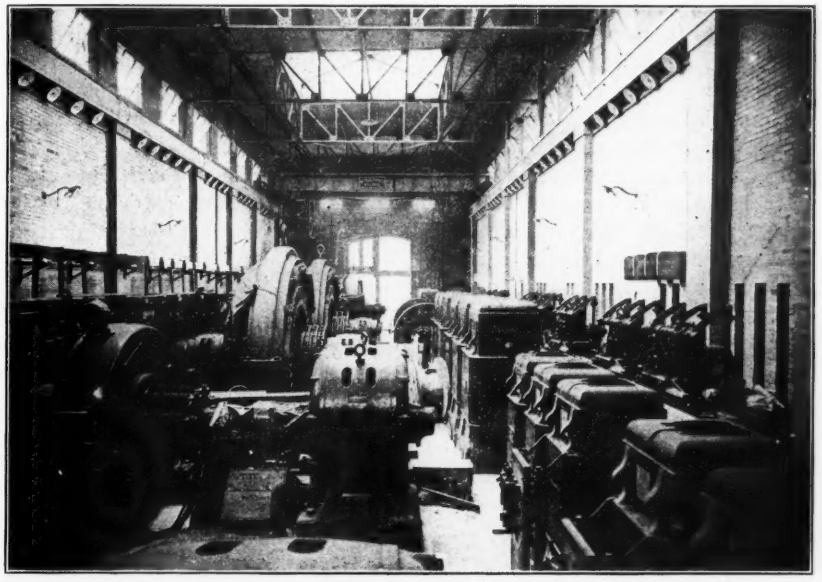
Heretofore, the four-track line of the Harlem division terminated on the north at Woodlawn. Between that point and Wakefield two additional tracks have now



YONKERS POWER STATION, LOOKING NORTHWEST.

GRAND CENTRAL YARD IMPROVEMENT.—GENERAL VIEW, SHOWING EXTENT OF EXCAVATION, LOOKING SOUTH FROM FORTY-NINTH STREET.

been laid, making four in all. On the Hudson division two additional tracks have been constructed, making four in all from the junction with the Harlem division at Mott Haven to Kings Bridge, some distance north of High Bridge; between High Bridge and Croton from two to four additional tracks are now under construction, involving, among other items, the building of the Marble Hill cut-off in the upper portion of Greater New York and the four-tracking of the existing two-track tunnel through Sing Sing prison. The construction of the proposed four-track tunnel for straightening the alignment south of Spuyten Duyvil has been postponed, pending the conclusion of negotiations with the city for the right to pass beneath city streets.



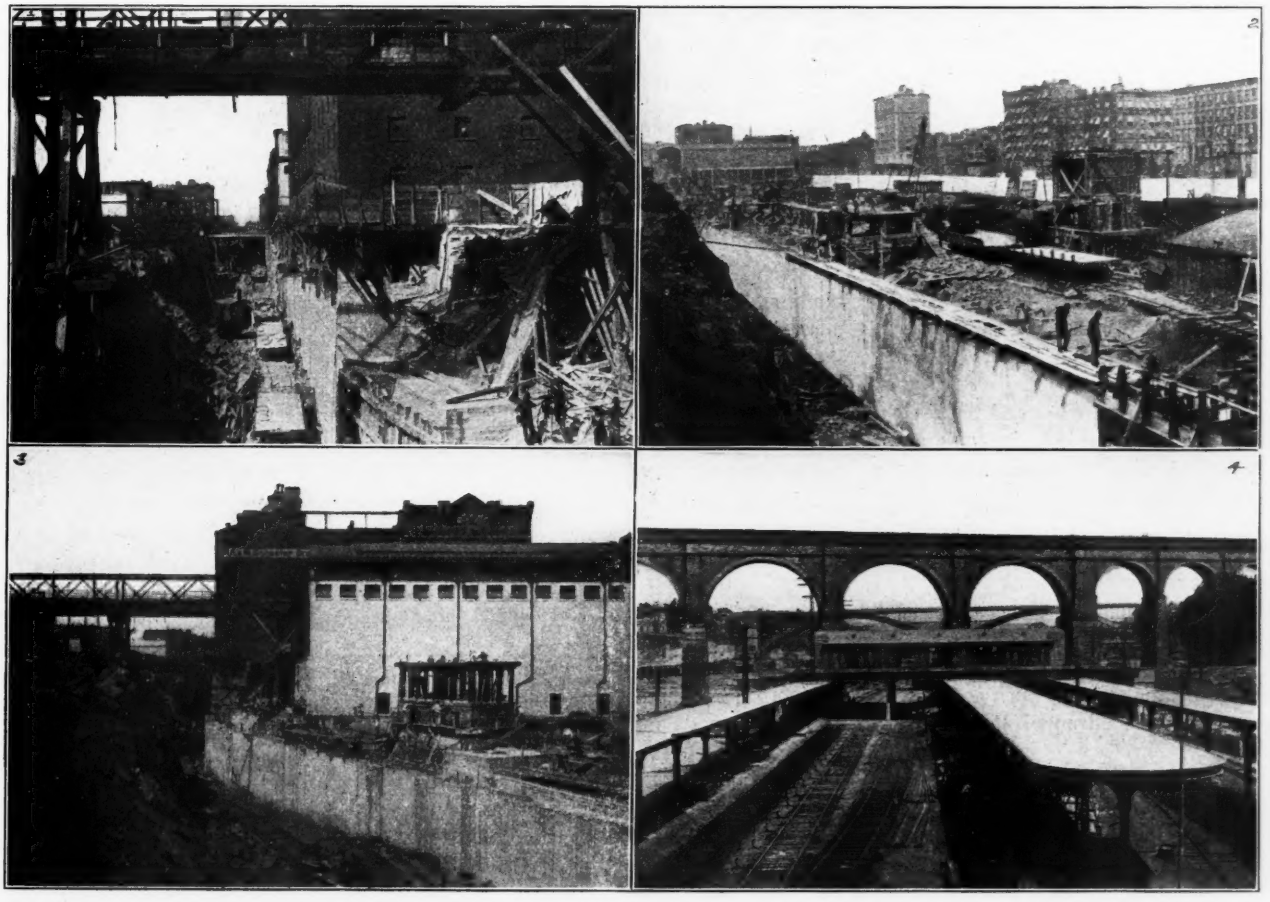
MAIN FLOOR, INTERIOR OF MOTT HAVEN SUBSTATION.

On the Port Morris branch between the Harlem river and the East river, at the terminus of which the Port Morris power station is located, the double-track line has been straightened and depressed so as to eliminate many street grade crossings, involving, among other items of heavy construction, a tunnel under St. Mary's Park.

Second only in importance to the change of motive power is the necessary radical change in signals and interlocking within the initial electric zone, as in conjunction therewith the direction of traffic is to be changed from left-handed to right-handed running.

The construction of the new all-electric interlocking plants and electric automatic signals with alternating-current track relays, the new signal bridges, towers, battery houses, substations, duct-lines, etc., is well under way.

For operating the ultimate electric zone



GRAND CENTRAL TERMINAL IMPROVEMENT.—1—SOME IDEA OF THE DIFFICULTIES. 2—THE HUGE RETAINING WALL. 3—ANOTHER VIEW OF THE WALL, THE TEMPORARY VIADUCT AND ONE OF THE SIGNAL TOWERS. 4—THE HIGH BRIDGE STATION.

two large power stations are provided, one of which, located at Port Morris, is completed and in regular operation, and the other, at Yonkers, is approaching completion. The power station at Port Morris has ample capacity to operate the initial electric zone.

The four substations for operating the initial electric zone are practically completed.

The construction of the transmission lines has offered a number of interesting problems, as all kinds of conditions have arisen that have necessitated different methods of treatment. For instance, through the Park avenue tunnel, pipe-ducts have been adopted hung either from the roof or the sides of the tunnel; on the Park avenue viaduct, pipe-ducts are used located on the tops or sides of the girders; under the Harlem river, submarine cables are used; from the Harlem river to Mott Haven Junction, vitrified ducts beneath the streets have been adopted; through the Harlem depression as far as substation No. 7, at Bronx Park, cables are placed in pipe-ducts hung from the sides of the retaining walls; from Mott Haven to the New York & Ptunam crossing near High Bridge, cables have been placed in vitrified ducts beneath the surface; northerly of the cable tower at the New York & Putnam crossing on the Hudson division and northerly of substation No. 7 on the Harlem division, cables have been placed on steel poles with substantial steel trusses where it is necessary to have the transmission line cross the railroad tracks.

All of the transmission line work, including circuit-breaker houses, is practically completed.

The third-rail working conductors are nearly finished, with the exception of the special work at important places like the Grand Central terminal, where it is expected that the finishing touches will be completed during the month of September. At a number of complicated places overhead construction has been found necessary so as to afford electric locomotives continuous contact, and this work is well in hand. Feeders and jumpers in connection with working conductors are progressing rapidly and will be finished early in September.

Electrical equipment consisting of locomotives, motor-cars and trailers has been partially delivered, and the remainder is coming along in time for use in regular operation in the fall.

Thirty-five electric locomotives will be needed for the hauling of through trains and 186 steel suburban cars will be used in the initial service, of which 125 are motor passenger cars, six motor combined express and baggage cars, and fifty-five trailer cars which can later be altered into motor-cars by the addition of electrical equipment.

The Field of a National Engineering Society.

By Calvin W. Rice.

EVERY reader of this article, whether or not a member, has ideas of the possible and legitimate activities of a national engineering society.

We will all agree at the outset, first, that the society must be of use to every individual member.

This in particular should mean that the member living far away must have quite as much thought and attention as the one near headquarters, and second, with the increase of membership the service must be proportionately varied, and the responsibility for rendering same is even greater.

Before starting to name some of the avenues of usefulness it is well to take an observation.

Engineering is passing into a new era. The necessity for specializing is greater at the present time than ever before, but the obvious advantages of cooperation among the several specialists was never more apparent, and the spirit of such cooperation was never more advanced than it is at present.

The national engineering societies are organizations of men for the mutual benefit of themselves and the general promotion of the "arts and sciences connected with engineering," but they will fail of substantial success if they lack the spirit of cooperation. Combinations do not bring about economy or general benefit, except that there is cooperation, and the latter, it is always inferred, will result when the former is recommended.

One very common mistake is the fear of the loss of identity in such combinations. This is an admission of the element of weakness on the part of the individual or association so deciding. It shows that that individual or society is thinking more of itself. He who forgets himself absolutely and works solely for the ideal will more surely attain success, and with it the reward—ungrudgingly allowed by his fellows, because unselfishly sought.

Several features suggest themselves, and they will be important, as they serve the greatest number.

A—The library service.

B—The making of acquaintances.

C—Research.

The library must be there for permanency, and is of prime importance, although most societies start and are kept alive by the social or human element.

Where possible, the circulating feature of the library should be permissable, and where not, then the organization should develop a department of research, so that a member may apply for "searches" on any subject. This would make, then, to every member a substantial acquisition to his resources.

The library is an ideal avenue of usefulness. This carries with it another, of which there is some doubt, but only according to the ability with which it is managed, the "Question Box" or bureau of information.

Theoretically, if not practically, all the members of a national engineering society are engineers, therefore their questions are legitimate and are not the attempt on the part of clients to secure for nothing engineering information and advice.

There has been a very substantial success in the Question Box for a particular meeting. Why not make it continuous?

If tried to a moderate extent it ought to be a living and practical benefit. Every engineer almost daily is meeting some problem which is more or less novel. If there could be a central bureau where assistance or suggestions could be immediately secured, this would be an invaluable resource to the membership.

B—One of the great benefits which one obtains from membership in a national society is the development of his acquaintanceship. This feature should then be the work of importance of the meetings. This should be the central object of its meetings about which everything revolves.

Make the programme attractive and of greatest profit so that full attendance is secured, then systematically provide the machinery for the members to meet each other.

The out-of-town member is the more deserving of attention and must have it. Particularly should the younger members

be brought in contact with the great men of the profession.

Let each meeting be so broadening and uplifting that, so to speak, one may see the spirit of the society grow. Further, this is inseparable from the ideals of professional honor, the standards of which are unconsciously formed at such times.

C—With the increase of strength of the society should come the desire for advanced work—research. In Germany this is undertaken by the government. In this country we have the large corporations and manufacturing establishments doing this in the most routine manner, considering that such is an essential to their progress.

For obvious reasons the individual can not do it.

The national engineering society is, therefore, the logical instrument to undertake research work in the lines of the activities of its members.

The society should be in a position to suggest topics for investigation to colleges whose graduating students are preparing theses. There should be especially close sympathy between the colleges and the national engineering society, and papers read before societies, and presumably the latest on a subject and the statement of actual experience, should be given to students as a text-book and the students required to abstract and discuss.

In a certain sense societies should lead and not follow. This is peculiarly true of standards. This is not only true in the atmosphere of professional honor, the standards for which the society should stand, but also the material standards of the arts.

To the extent that America is to excel must we adopt standards in manufacture, standards of measure, specification, strength of materials, etc. To maintain interest a magazine should be published, not to encroach on the regular publications as such, but just to cover the items of peculiar interest to members of the society.

While the foregoing cover the wants of the majority, yet there are numerous other activities which combine to reach every member, which, we have all agreed, must be served.

Such another work is the maintenance of an employment bureau.

It ought to be true that a member is never long out of employment. The very fact that he has not been permitted to join till his record has been proved separates such a man from the average applicant and in general should make him acceptable. On the other hand, it is most natural that the headquarters of a society should receive requests for men, and these should be conscientiously passed on to the members as their due.

All of these opportunities of national engineering societies are founded on cooperation between the members, each contributing to the success of the whole.

An evidence of the progress of the spirit of cooperation in engineering is the Union Engineering Building. Here will many societies make their headquarters, each preserving identity and constituency, but will combine libraries, and it is to be hoped in some intimate way with the technical sections of the New York Public Library developing a true centre of engineering in America. But let the influence be to an ever-receding horizon, and with its growth the society takes its natural office as leader of the profession.

The Single-Phase System in Steam Line Electrification and Electric Railway Development.

By Calvert Townley.

THE remarkable success of the American nation in the family of nations is undoubtedly due, in a great measure, to the vigor and persistence with which the average American man attacks the problems before him, whatever they may be. He has been trained to do whatever he has to do as hard and as quickly as he can. One effect of this training has been to make us a nation of partisans and to give us a persistence in adhering to our individual ideas and a delight in seeing those ideas carried forward to a successful conclusion against opposition of varying kinds and intensities. Knowing this, it behooves all engineers to discriminate as clearly as they can between the fixity of purpose, the energy and persistence necessary for a successful conclusion to any enterprises entrusted to them, and the danger of regarding as a part of their duty partisanship as to engineering methods. It is natural that a manufacturer of machinery who has succeeded in producing a new device, marking a step in the advance of his art, should urge upon the public all the advantages of his invention for purposes of commercial gain, while his less fortunate competitors should combat with equal vigor the introduction of something which will take their business away. The value of an engineer to his client lies, to a considerable extent, in his ability to discriminate between such opposing claims in determining the value of any advances that may be made in his art, so that his client may make the best use of any new weapon in the battle of progress and escape being misled by false prophets.

I have heard electrical engineers complain that their profession is not given the standing to which it is entitled by the importance of the interests involved. There is ground for this complaint, and it is, no doubt, due in part to the newness of the industry, and to the lack, until recent years, of many high-grade neutral engineers. It can not be successfully denied, however, that this condition is also in no small degree due to their own readiness to belittle each other's work. A public, or even a private, attack on a brother engineer may injure him. It is more likely to injure the author of it. It certainly does not tend to raise the standard of the electrical engineering profession in the minds of the business public, on whose favor all engineers depend. An engineer usually strengthens himself by saying a good word for a brother engineer when opportunity offers. He can always discourage by ignoring them, or by disparagement, attacks made by others. The temptation to make public reply to some half-baked criticism of one who has rushed into print about your work, and who has thereby laid himself wide open for a telling retort, is undeniably strong, but it should generally be resisted.

The production of a commercial single-phase alternating-current motor for railway service by B. F. Lamme has placed a new weapon in the hands of the railway operator and his engineering advisors, about the use of which much has been said and written, both favorable and otherwise. The importance of this invention is very generally recognized, but its bearing on many of our modern problems is frequently misunderstood. A brief analysis

of the situation may not be out of place and may perhaps assist in preventing our regarding this motor as a panacea for all our previous ills, or, on the other hand, as a quack nostrum which will soon be discredited by a later development.

The application of electricity to the propulsion of cars involves three entirely separate and distinct essentials, *i.e.:*

1. The generation of electric power from the prime mover;

2. The transmission of such power from the point of generation to the moving vehicles; and

3. Its reconversion at those points again into mechanical power applied to the wheels.

The single-phase alternating-current motor has done essentially one thing, and one thing only, *i. e.,* it has made possible the use of simpler methods of transmitting power from the power-house to the moving vehicles. It has radically changed neither the method of generating power in the first place, nor the method of utilizing it in the third place. Power-houses for the production of single-phase alternating current differ in no marked degree from our standard polyphase power-houses. The alternating car or locomotive equipment, while changed much in detail, is likewise similar in all its elementary features to the car or locomotive equipment previously used with continuous current. Therefore, whether or not the single-phase alternating-current system is desirable for any particular installation depends in a very large degree—I had almost said depends altogether—on how valuable may be the simplified methods available for distributing electrical energy which its use permits.

The essential difference between the alternating and the continuous currents is that the relation between the pressure and quantity can be readily changed in the alternating current, whereas with the continuous current such change involves the introduction of cumbersome, complicated and expensive devices. The ability to transmit energy in the form of a high-pressure current permits smaller and less expensive conductors and simplifies the moving contact mechanisms for connecting the stationary conductors with the moving car. If the distances of transmission are short and the energy to be collected by any unit relatively small, the above-named advantages largely, or entirely, disappear; and, conversely, if the distances of transmission are great and the amounts of energy to be used per unit large, the advantages of the alternating current become more valuable.

Steam railroad service as compared with trolley service furnishes greater average distances and requires larger units of power. Therefore, the distributing simplicity of the alternating current has a greater relative value than in city trolley systems.

The disadvantages of the single-phase system are largely those which are incident to its newness. The car equipments as at present built are heavier, and they are more expensive. The details of the auxiliary parts are still somewhat more complicated, and they have not as yet been perfected in design. The introduction of higher trolley voltages means better insulation and the adoption of additional precautions to protect the traveling public against shock. All of these objections may fairly be put in the same class as the objections which have been many times encountered in the past twenty years' development of the electrical industry, and which objections we may confindently expect will be duly removed by the ingenuity and persistence of the American designer. The present arguments between advocates of the single-phase railway system and of the continuous-current railway system remind one forcibly of the debate of eighteen to twenty years ago as to the relative merits of alternating and continuous current for lighting. They should not be allowed to cloud or confuse the underlying and elementary facts which govern. An attempt to universally introduce the single-phase railway system would be doomed to failure at once by reason of its imperfect interchangeability with the continuous-current system already in use on all the large trolley systems. The folly of discarding a satisfactory and successful continuous-current apparatus, and thus sacrificing present investments for the purpose of catering to a new fad, is even less pardonable in an engineer's advice to his client than would be a neglect to take advantage of the single-phase system by reason of the conservative, but natural, mistrust of its new and somewhat untried features. By all means let us, in the first place, have as full information as possible, and, in the second place, countenance nothing but the most thorough consideration of the needs of every individual problem.

Much has been said and written about the electrification of steam railways, and prognostications freely made by enthusiastic electrical partisans who relegate the steam locomotive promptly to the scrap heap. The average man, however, has no very clear idea of what really does govern electrification, nor where it can reasonably claim material advantages. Comparing the two methods of propelling cars it will be noted that the motive power, in the first place, is, in either event, generated by burning coal—for the steam locomotive under its portable boiler, and for the electric locomotive under a stationary boiler in the power-house. In the second place, the steam produced is used to drive an engine, likewise portable in the case of the steam locomotive, and stationary in the case of the electric locomotive. Here, however, the steam locomotive scores a distinct advantage, because its steam is applied directly to produce propulsion, whereas in the electric system the energy must still go through several transformations, requiring complicated and expensive equipment, and entailing severe energy losses. Therefore, in the case of a one-train railroad, the electric system is clearly outclassed. Suppose now that we multiply the traffic by 100, and consider a railroad on which 100 trains on an average are in service, what are the conditions? We now burn coal under 100 portable boilers for steam locomotives, or under suitable batteries of stationary boilers in the power-house for electric operation, while steam is applied in 100 sets of locomotive cylinders in one case, or to a few large engines in the power-house in the other case.

It is perhaps worth while to here comment on the fact that the use of electricity has nothing whatever to do with the generation of power; in fact, it is not a source of power at all, but simply a means of transmitting power which is generated by the prime mover to the point where such power can be used, an attenuated flexible steam pipe, if you will, between the power-house and the moving train.

Now, having in effect an infinite boiler capacity on every engine, and likewise having in effect the ability to enormously increase the cylinder dimensions of the locomotive without increasing its weight, it becomes possible to do with the electrified system what was previously, with steam traction, entirely out of the question, and a new and very interesting situation is created. The limit of the weight of trains which can be hauled, and of the speed which they can maintain, is usually the power of the locomotive which draws them. The limit of the power of the largest locomotive that may be used is the strength of the track, bridges, etc., to withstand heavy weights, and this means that beyond a certain milestone in the progressive increase of a railroad's business there must be reconstruction, always at enormous expense and at a loss of valuable time, and usually at a severe handicap to

operation. These difficulties electrification largely avoids, and, therefore, on a congested railroad system where increased train weights and speed, or both, are of value, electrification unquestionably affords facilities which are beyond the reach of steam.

In the matter of the number of trains which can be operated over a given track and the measure of their safety of operation, there is a different condition introduced by the use of electric traction. Present practice provides safety by signaling an approaching train whether or not there is another train in the block ahead. Experience has shown that locomotive engineers too frequently disregard such signals, relying on their watchfulness to avert an accident. The signal man in the tower having set a danger signal is powerless to take further action, and, in fact, has less incentive to do so, knowing that he will be held blameless as soon as it is shown that his signals were properly set. The natural tendency of the above situation is to cause railroad managers to somewhat lengthen their blocks, and thereby decrease the track capacity in an effort to increase the margin of safety. With an electric equipment, suitably placed switches enable the tower operative to cut off current from any section of track, so that an ag gressive engineer who overruns his signal will promptly find himself without power, and with the certain assurance that the incident will be reported by his conductor and by the tower man, and that he will be promptly up for punishment. The result of this practice must unquestionably be a physical increase in safety and must have an excellent moral effect in enforcing an observance of rules by the operatives, with the ultimate result of enabling shorter blocks to be used and increasing the train capacity of any given track.

The foregoing are some of the possibilities of steam road electrification, entirely aside from these usually given the greatest prominence, *i. e.*, cost of installation and economy of service, freedom from smoke, cinders, etc. I will not comment on these matters, as they have been frequently and fully discussed, and as there are rapidly being accumulated facts and figures from actual service which will set at rest various and sundry disputed points.

There are many roads which it will obviously pay to electrify. There are others which it obviously will not, but in between these two extremes and grading one into the other by almost imperceptible steps come many cases which are debatable ground. Investment and economy will always play important parts in every decision, and if the single-phase system can reduce that investment and increase the economies, and if it will lengthen the stretches which can be economically equipped and operated, it has advanced the art of electric railroading by an appreciable degree, has placed a new and valuable weapon in the hands of electrical engineers, and has correspondingly broadened the field for the application of electric traction to existing steam roads.

Problems in the Chemistry of Rubber.[1]

There is no more important group of questions demanding attention from the chemist at the present time than those connected with the production of india-rubber or caoutchouc. An enormous increase in the demand for india-rubber has taken place in the last few years, and last year the production was not less than 60,000 tons. Until recently the supply of rubber came chiefly from two sources—the forests of Brazil, which contain the tree known as *Hevea Brasiliensis,* furnishing the Para rubber of commerce which commands the highest price, and the forests of Africa, where climbing plants, generally of the Landolphia class, also furnish rubber. The increased demand for caoutchouc has led to the extensive planting of the Para rubber tree, especially in Ceylon and in the Federated Malay states. Systematic cultivation and improved methods of preparation are responsible for the fact that the product of the cultivated tree, which begins to furnish satisfactory rubber when six or seven years old, is now commanding a higher price than the product of the wild tree in Brazil. It is estimated that within the next seven years the exports of cultivated india-rubber from Ceylon and the Federated Malay states will reach between ten and fifteen million pounds annually, and that after fifteen years they may exceed the exports of the so-called wild rubber from Brazil. The services which chemistry can render to the elucidation of the problems of rubber production and utilization are very numerous. Methods of treatment depending on a knowledge of the other constituents of the latex have led to the production of rubber in a purer condition. Much still remains to be elucidated by chemical means as to the nature of the remarkable coagulation of the latex. As is well known, the latex is a watery fluid resembling milk in appearance which contains the rubber, or, as I think more probable, the immediate precursor of rubber, together with proteids and other minor constituents. The constituent furnishing rubber is in suspension, and rises like cream when the latex is at rest. On the addition of an acid, or sometimes of alkali, or even on mere exposure, coagulation takes place and the rubber separates as a solid, the other constituents for the most part remaining dissolved in the aqueous liquid or "serum." The first view taken of the nature of the coagulation process was that, like the coagulation of milk by acids, it is dependent upon a process of proteid coagulation, the separated proteids carrying down the rubber during precipitation.

This explanation can not, however, be considered complete by the chemist, and there are peculiarities connected with the coagulation of the latex which are opposed to the view that it is wholly explained by the coagulation of the associated proteids. A number of experiments were made at the Imperial Institute with latex forwarded from India, and the results obtained, especially with reference to the behavior of certain solvents toward the latex, led to the conclusion that "coagulation" can take place after removal of the proteids, and that in all probability it is the result of the polymerization of a liquid which is held in suspension in the latex and on polymerization changes into the solid colloid which we know as caoutchouc. Although the nature of the process is not yet completely elucidated, there is little room for doubt that the coagulation is due to the polymerization of a liquid, and possibly of a liquid hydrocarbon contained in the latex. For the chemist the important question remains as to the nature of this liquid from which caoutchouc is formed.

The discovery of better methods of coagulation, preparation and purification will be effected through chemical investigation, as will also the determination of the manner of utilizing the various other plants which furnish rubber-like latices. That the physical properties of raw rubber, on which its technical value depends, are to be correlated with the chemical composition of the material there can be no doubt. The chemical analysis of raw rubber, as at present conducted, is, however, not always to be taken by itself as a trustworthy criterion of quality, and more refined processes of analysis are now

[1] Excerpt from an address delivered by Professor Wyndham Dunstan before the chemical section of the British Association, at York, on "Some Imperial Aspects of Applied Chemistry."

needed. Although the finest caoutchouc for technical purposes is only yielded by half a dozen plants, under whose names these varieties of caoutchouc pass, there can scarcely be a doubt that the elastic substance in each case possesses a very similar, if not identical, chemical structure. Nearly all the latices and similar fluids furnished by plants contain more or less caoutchouc. Even opium, which is the dried juice of the capsule of the poppy, contains caoutchouc, while the opium yielded by certain Indian species contains a notable proportion. Chemistry must determine the means by which caoutchouc can best be separated from these relatively poor latices. In view of the increasing production of the nearly pure caoutchouc which is furnished by *Hevea Brasiliensis, Funtumia elastica, Castilloa elastica, Ficus elastica,* and a few other plants which occur or can be cultivated in several of our tropical possessions, the question is not a pressing one at the moment. Moreover, it can not be doubted that chemical science will sooner or later be able to take a definite step toward the production of rubber by artificial means.

The production of caoutchouc by chemical means has, indeed, virtually been accomplished in its formation from isoprene. The exact nature of this change has still to be determined. When this has been done it will only remain to cheapen the cost of production to make the manufacture of synthetic rubber a purely practical problem. I should be the last to discourage the great extension of rubber planting which is now taking place. It is warranted by the present demand for the material. It has also to be remembered that the actual cost of producing raw rubber, which is at present about twenty-five cents per pound, will probably be reduced, and the market price of rubber may eventually be so considerably lowered that, as with quinine, the synthetic production could not be profitably carried on.

As I have said, our science is concerned with nearly every problem connected with the great rubber industry, and in concluding these few remarks I may allude to the production of vulcanized rubber depending on the formation of additive compounds of the hydrocarbon with sulphur. In this connection I should mention the recent experiments of Mr. Bamber in Ceylon, which appear to show that vulcanization may be accomplished by acting on the uncoagulated latex with chloride of sulphur. If this proves to be practicable, it may mean the transference to the tropics of the subsidiary industry of vulcanizaton, which is at present carried on in Europe.

Improving the Italian Telephone Systems.

United States Consul Paul Nash, of Venice, Italy, reports that the telephone systems of that country will be rapidly improved and brought up to a modern condition.

The telephone service in Italy, both urban and intercommunal, has hitherto been almost entirely in the hands of two great companies—the Societa Alta Italia, operating in Milan, Genoa and Turin, and the Societa Generale Italiana pei Telefoni ed Applicazioni Electtriche, controlling Bologna, Florence, Rome, Naples and the Sicilian towns.

In the beginning of 1904 the ministry of posts and telegraphs took over the Venice telephone system, extending the service, raising the pay of the employés, and reducing the rates, but, in spite of increased expenses, putting aside some $12,000 a year toward a fund for the changing of the entire system. The time has now come when bids for this change are being made, and already three have been received—one from an American, one from a French and one from a German firm. These bids are yet to be submitted to the ministry at Rome by the local director, and there is still time for other American firms to compete if they act promptly.

The ministry of posts and telegraphs recently appointed a commission to investigate the telephone service throughout the country, with the result that in many places a complete change was found to be necessary. In Rome, for example, the service was found to be extremely bad, and that town will probably be one of the first to be modernized in this respect. The appointment of this commission was the first step in the project of the ministry to take over control of the telephone service of the whole country. Thus the moment seems most propitious for investigation by our manufacturers, and because the government will undoubtedly prefer a uniform system throughout Italy an immense business might possibly be the reward of the successful bidder for the modernization of the service in the first large towns in which it is undertaken under government control.

The director of the local exchange says that the central-battery system is in use at Milan, and that as it gives perfect satisfaction the tendency will be to adopt it generally. He also says that of the three propositions already submitted to him for the new exchange in Venice that of the American firm seems to be the best, and that although the actual choice does not rest with him he believes the minister will award the contract to this firm, provided, of course, nothing better is forthcoming.

American desk telephones should find a ready sale in Italy. The only thing of the kind in use in Venice is a French production known as the Bailleux-Ader, which, although excellent as far as mechanism is concerned, is enclosed in a large wooden box, and is too heavy and cumbersome for convenience.

The Railway Signal Association.

The next meeting of the Railway Signal Association will be held at the Great Northern Hotel, Chicago, Tuesday, September 11, 1906. A paper entitled "Standard Specifications for Mechanical Interlocking" will be discussed and certain revisions recommended for consideration and action at the annual meeting.

"Identification Marks for Wires and Cables From a Maintenance Point," will also be considered.

The secretary announces that on account of the presence in Washington, D. C., of two other large conventions on October 9, 10 and 11 (dates noted for holding the annual meeting), and a scarcity of room to hold sessions and facilities to display apparatus and materials, the executive committee left it to a vote of the active members to select a new date, which is now fixed by this vote as October 16, 17 and 18.

The New Willard will be the association headquarters.

Improvements in the Tantalum Lamp.

It is reported in the foreign journals that some improvements have been made in the tantalum lamp as manufactured by the Siemens & Halske Company, of Berlin, Germany. The useful life of the lamp has been increased to 600 hours for the "H" type standard, and to 800 hours for the "L" type. The average total life may be taken as equal to that of the ordinary carbon lamp. These figures have been adopted provisionally for commercial purposes, although it is said that actual tests made on a large scale at the factory have shown better results. It has been found that if half of the bulb away from the base be frosted that a much better distribution of light is obtained, more being thrown downward. This method of construction will be adopted as standard practice.

LETTERS TO THE EDITOR.

Electric Motors for Operating Stone-Crushing Machinery.

To the Editor of the Electrical Review:

Have you any information as to the successful use of electric motors operating large stone-crushing machinery? We shall be obliged if you can give us some specific information as to the practicability and economy of such service. If you have not this information at hand, can you advise us where the same can be obtained?

The Genesee County Electric Light, Power and Gas Company,
R. M. Walker, Secretary.

Batavia, N. Y., August 29.

Electric Limiting Device.

To the Editor of the Electrical Review:

I understand that there is on the market a limiting device by the use of which electric lights will flash when a certain load is exceeded. I would be glad if you could give me any information concerning this device, or place me in communication with any of the manufacturers thereof.

Canadian Electrical Association,
T. S. Young, Secretary-Treasurer.

Toronto, Ontario, August 29.

Cost Table Wanted.

To the Editor of the Electrical Review:

If you have ever published a table or tables showing relative or approximate cost per kilowatt-hour to generate current under different conditions, please mail it to me and I will remit cost.

Greenwood Water and Electric Light Plant,
A. J. Sproles, Superintendent.

Greenwood, S. C.

A Unique Electric Motor Installation.

There are many mills, especially in New England, which depend on two sources of power for their operation, either using water under ordinary conditions, or having an auxiliary steam plant to carry the load when the water fails during the dry season. An interesting adaptation of electricity as an auxiliary motive power under these conditions is to be seen at the mills of the Joslyn Manufacturing Company, South Scituate and Hope, R. I. This company operates three mills for the manufacture of shoe laces and corset strings: the Richmond mill, on the Ponogansett river; the Ponogansett mill, two miles above the first on the same stream; and the Rockland mill, situated about three-quarters of a mile west of the Ponogansett mill.

The scheme in which electricity is used to adjust the differences between steam and water is highly interesting. The idea throughout the mills is to get along without using the steam engine. The Rockland mill, located between the other two of the series, contains a small power-house in which is installed a water-wheel-driven, 200-kilowatt, 2,300-volt, three-phase General Electric generator, with switchboard. The mill is driven by a 175-horse-power induction motor supplied from this generator. The steam engine with which the mill was equipped as a reserve is retained for that purpose, but will probably never be used, as at dry periods all of the available water is utilized by this mill alone, the pond near the Ponogansett mill serving as a storage basin against the droughts. The electrical equipment in the Rockland mill thus supplies power to operate that mill and assists, as well, to operate the other mills throughout the year.

The Richmond mill, the second mill of the three, operating twenty-four hours per day, ordinarily uses the water power of the Ponogansett river, but has a steam engine auxiliary for emergency. Here the electrical unit consists of a seventy-five kilowatt machine, which can be operated either as a generator or synchronous motor according to the following schedule: when the plant is operated by water power, this unit is belted to the line shaft and runs as a generator in multiple with the 200-kilowatt generator at the Rockland mill, taking its share of the load. When the water is low the unit is used as a motor, drawing current over the transmission lines from the Rockland mill generator. The Richmond mill engine is, therefore, seldom, if ever, used.

At the third mill, the Ponogansett, there is a ten-hour working day, and water power is depended upon entirely for operating the machinery. In this mill a sixty-horse-power motor is used to drive the line shafting, while a one-hundred-kilowatt synchronous unit operates either as a motor or generator in a similar way as in the Richmond mill.

Both the Richmond and the Ponogansett mills are lighted by electricity, taking current through transformers from the transmission line.

In addition to this ingenious method of obtaining the most economical operation, the installation is further noteworthy because of the use of high-voltage motors within the mills. The transmission line enters each mill in rubber-insulated, lead-covered cables, laid in galvanized-iron loricated conduit with the sheath grounded. The motor frames are likewise connected to earth, so that all danger of fire or shock is eliminated. The electrical equipment, including induction motors, synchronous motors (or generators, as the case may be), and exciters as well as the switchboards, was furnished by the General Electric Company.

Recent Advances in Steam Turbines—Land and Marine.

At the recent meeting of the British Association for the Advancement of Science, held at York, England, a paper entitled "Recent Advances in Steam Turbines—Land and Marine," was read by Gerald Stoney.

The author dealt first with the development in the use of steam turbines for driving dynamos and alternators, from the first one, made in 1884 by the Hon. Charles A. Parsons, of ten horse-power, to the great ones of 8,000 horse-power used in the great power stations of Carville, Neasdon, Chelsea, Paris, etc.

He then described the further development of the steam turbine for driving rotary air compressors of the turbine type now largely used for blowing blast furnaces and other work, and pointed out the advantages gained—light weight, small foundations, small consumption of oil, and, above all, high economy of steam. These are generally for about 20,000 cubic feet free air per minute, and a pressure of ten to fifteen pounds per square inch. A slightly different type is also made for about 30,000 cubic feet per minute, at about one pound per square inch pressure. These are used in several large iron works and elsewhere for dealing with the waste gases from furnaces, and for driving these gases through the recovering plant, etc., an important point being that they do not clog with tar and other matters.

Since it is almost, if not quite, impossible to utilize economically low-pressure steam at about atmospheric pressure in a reciprocating engine, the exhaust-steam turbine becomes of importance in many cases where there are non-condensing engines and other sources of exhaust steam. Several such installations were described and the high economy attained by such turbines was explained.

As a steam turbine can utilize the highest vacuum attainable to its full extent, the use of the vacuum augmentor described in a paper before the English Institution of Civil Engineers of Great Britain, read in December, 1905, was given, with some instances of the high vacua obtained in practice by its help.

In conclusion, the marine turbine was briefly touched upon, and the great development from the little "Turbinia" of 1897, to the gigantic Cunard express liners of to-day, was described.

Discovery of the Mariner's Compass.

We are indebted to a magazine published about seventy years ago for the following paragraph: "Much interest must forever attach to the discovery of this instrument, and yet there are few subjects concerning which less is known. For a period the honor of the invention was ascribed to Gioia, a pilot or ship captain born at Pasitano, a small village situated near Malphi, or Amalfi, about the end of the thirteenth century. His claims, however, have been disputed. According to some, he did not invent, but improved it, and according to others he did neither. Much learning and labor have been bestowed upon the subject of the discovery. It has been maintained by one class that even the Phœnicians were the inventors; by another that the Greeks and Romans had a knowledge of it. Such notions, however, have been completely refuted. One passage, nevertheless, of a very remarkable character occurs in the work of Cardinal de Vitty, Bishop of Ptolemais, in Syria. He went to Palestine during the fourth crusade, about the year 1204; he returned afterward to Europe, and subsequently went back to the Holy Land, where he wrote his work entitled 'Historia Orientalis,' as nearly as can be determined, between the years 1215 and 1220. In chapter xci of that work he has this singular passage: 'The iron needle, after contact with the loadstone, constantly turns to the north star, which, as the axis of the firmament, remains immovable, while the others revolve; and hence it is essentially necessary to those navigating on the ocean.' These words are as explicit as they are extraordinary; they state a fact and announce a use. The thing, therefore, which essentially constitutes the compass must have been known long before the birth of Gioia. In addition to this fact, there is another equally fatal to his claims as the original discoverer. It is now settled beyond a doubt that the Chinese were acquainted with the compass long before the Europeans. It is certain that there are allusions to the magnetic needle in the traditionary period of Chinese history, about 2,600 years before Christ; and a still more credible account of it is found in the reign of Chingwang, of the Chow dynasty, before Christ 1114. All this, however, may be granted, without in the least impairing the just claims of Gioia to the gratitude of mankind. The truth appears to be this: the position of Gioia in relation to the compass was precisely that of Watt in relation to the steam engine—the element existed, he augmented its utility. The compass used by the mariners in the Mediterranean during the twelfth and thirteenth centuries was a very uncertain and unsatisfactory apparatus. It consisted only of a magnetic needle floating in a vase or basin by means of two straws on a bit of cork supporting it on the surface of the water. The compass used by the Arabians in the thirteenth century was an instrument of exactly the same description. Now the inconvenience and inefficiency of such an apparatus are obvious; the agitation of the ocean, and the tossing of the vessel, might render it useless in a moment. But Gioia placed the magnetized needle on a pivot, which permits it to turn to all sides with facility. Afterward it was attached to a card, divided into thirty-two points, called Rose de Vents, and then the box containing it was suspended in such a manner that, however the vessel might be tossed, it would always remain horizontal. The result of an investigation participated by men of various nations, and possessing the highest degree of competency, may thus be stated. The discovery of the directive virtue of the magnet was made anterior to the time of Gioia. Before that period navigators, both in the Mediterranean and Indian seas, employed the magnetic needle, but Gioia, by his valuable improvement in the principle of suspension, is fully entitled to the honor of being considered the real inventor, in Europe, of the compass as it now exists."—*Electrical Engineer, London.*

The Electrical Discharge in Air and Its Commercial Application.

A paper was read before Section B (chemistry) of the British Association for the Advancement of Science during the recent meeting at York, England, by Messrs. Cramp and Leetham, dealing with "The Electrical Discharge in Air and Its Commercial Application." This paper described an apparatus for the production of bleaching and sterilizing gas obtained by causing an electrical discharge to take place through air, the gases being used for treating flour.

The paper was divided into three sections:

1. The Construction and Application of the Apparatus—This consists essentially of an alternator, transformer, ozonizer and spark-box, the two latter being in series on the high-tension side of the transformer. A current of air is caused to pass through these while they are excited, the general result being an extremely active modification of the air supplied.

2. The Electrical Phenomena Involved—This section includes an investigation of the laws which govern the various types of electrical discharge.

3. The Chemical Phenomena Involved—This section includes the results of analyses, etc., of the gases used, together with an account of their action upon the flour.

Lantern slides illustrating the construction of the apparatus, and the behavior of the different types of discharge, were shown.

The authors found that

a. All the types of electric discharge behaved similarly, and needed similar means for rendering them steady.

b. With a properly arranged circuit any desired type of discharge might be obtained, and, by proper regulation, might be gradually caused to pass to any other type.

c. The number and distance apart of the discharge points, the shape of these points, the air velocity, and the frequency, all effected the discharge produced.

d. So long as the air resistance was very high, the chief modification in the air was the production of ozone; but with a gradual breakdown of the air resistance oxides of nitrogen were yielded, though this change did not appear to depend upon the temperature of the apparatus, as might have been expected.

e. The gas yielded was always in a state of ionization—but the higher the air resistance, the less marked was this ionization.

f. Contrary to the statement of many authorities, ozone and oxides of nitrogen were found to exist side by side, without mutual destruction.

g. The bleaching action of the gas appeared to be due to oxidation.

h. Flour, treated by the gas, was found, for some unexplained reason, to absorb more water than similar flour untreated.

The Sons of Jove.

On Tuesday, September 11, 1906, it is expected that a large attendance of the present membership of the Rejuvenated Sons of Jove will attend a meeting and initiation at Niagara Falls, N. Y. This order is rapidly growing in numbers and is gaining strength throughout the entire electrical fraternity. The organization is for the promotion of goodfellowship and closer acquaintanceship among the workers in the electrical industry.

The Benefit of Enquiry to Lightning-Arrester Practice.

By N. J. Neall, Consulting Electrical Engineer, Boston, Mass.

IN REVIEWING the development of electrical apparatus one must be deeply impressed by the fact that almost at the beginning of modern electrical transmission work the necessity was realized of having protection against lightning and similar static disturbances. In fact the future of such electrical development hinged very materially on the ability to find some means of protection. The methods followed previously by workers in telegraphy could not now be followed absolutely, because of the presence of the electric current in comparatively large values, which necessitated the discovery of some device which would discharge the line of its static disturbance and yet at the same time not allow a short-circuit to maintain itself.

It is greatly to the credit of the manufacturing companies of a decade ago or more, and to such men as Thomson, Wurts and others, that the matter was not only thoroughly investigated in its essentials, but certain elements of protection were devised or discovered which have proven themselves of permanent value.

It is of course to be recognized that the manufacturing companies were not purely disinterested in thus investigating lightning disturbances, and any features of general interest which may have been discovered were accidental rather than purposely sought out. This limitation of interest was, of course, not so easily recognized years ago as it can be recognized to-day, simply because the development of electrical apparatus has been not only so great but in its main features so successful, that the performance of the lightning arrester has been relegated to a secondary position of interest. For example, generators, transformers, motors, measuring instruments and many other such devices have been developed to a point wherein failure from inherent defects of construction are rare, if not unlooked for. Recently, however, the transmission of power over long distances—and this is a relative expression which applies equally as well to hydroelectric installations as to our larger systems of electric railways—has once more brought the subject of lightning disturbances prominently to our attention. It also happens that the higher potentials now being taken up, such as 50,000 to 60,000 volts, have apparently reached the upper limit of electric strength of such protective apparatus as has heretofore been reasonably successful.

We therefore stand at the interesting point of investigation into the future possibilities of protection for very high voltages, as well as determining the degree to which all our systems must yet be protected. We thus find that by the gradual elimination of imperfect design electrical engineering of power transmission to-day is confronted by practically one problem, *viz.*, successful lightning protection. And it is a question to be discussed briefly in this paper in how far our present knowledge and facilities for investigation will enable us to make up for the large amount of neglect given lightning protection during the last decade.

There are several ways in which this subject can be approached, and probably the most successful, certainly the most systematic, will be by the manufacturer, principally the larger manufacturers of electrical apparatus. If such work as has been done in the past under the auspices of the Westinghouse Electric and Manufacturing Company and the General Electric Company, through whom engineering literature on this subject has been much enriched, is carried into the future, there is much to expect of a satisfactory nature. If it were not for the commercial considerations involved, probably the most effective way of investigating this subject would be by a combination of all the parties interested, thereby eliminating all needless repetition and effecting a greater economy of expenditure for the results obtained. This is perhaps asking too much, but it indicates an element which would mean much for the future of this branch of engineering.

There is a larger field of investigation in which the manufacturers can not freely operate and wherein it is unnecessary that they should. This is the field of operation. Every station manager, every superintendent of a transmission system, has within his power a very simple means of obtaining valuable information as to the behavior of lightning protective apparatus, and it is interesting to know that the degree to which this has been taken up has been not only quite meagre but only of recent date. Such a method of investigation as is here referred to consists in placing some form of telltale paper in the protective apparatus in such a way as to have a record of its operation. In the case of a large plant this means quite an extensive investigation, but still very simple. By means of a record kept of these discharges from week to week, or oftener as circumstances might require, the manager of a system has not only a knowledge of the extent of the disturbances to which it has been subjected, but also a definite elimination of a certain amount of uncertainty as to the cause of any failure of apparatus from lightning.

On the surface this method seems wonderfully simple, and it is possibly because of this very simplicity and the need of persistence in its continuance that it has not been more warmly taken up. In such cases where this method has been followed important results have been secured which have been of benefit from the standpoint of operation and even of significance to the manufacturers. In several cases they have pointed to further needs of protection which would not otherwise have been apparent. In addition to this, photography and test papers with time movement can be advantageously employed.

Inasmuch as the average station operator has so many harassing duties to perform the investigation of lightning-arrester operation seems on the surface rather trivial. When one considers, however, that this can be done at small expense, after it is once started, and realizes at the same time the value of the apparatus indirectly involved, the point of view can be readily shown to be mistaken. As a matter of fact the very improvement in apparatus hereinbefore mentioned is bringing the subject of lightning protection more vividly to the attention of the operator, and whether he wishes to do so or not the value of a reputation for uninterrupted service demands that all possible steps be taken to the end that lightning, at least, be rendered harmless to operation.

The recent reports under the auspices of the National Electric Light Association show the trend of sentiment in this direction, and indicate the great value which a combination of interests can have in this connection, wherein individual effort might fail or be fruitless. These reports have, of course, comprised the results of observation limited to the membership and are therefore not as universal as might be desired. The fact, however,

that in the report of the present year 113 companies have seen fit to respond, is not only significant of the interest felt in the matter but is also encouraging to the belief that the next five years will see a vast deal of misconception of the matter laid aside simply because of this sane method of presenting facts, not to speak of a greater efficiency in protection afforded thereby.

This report, entitled "Report on Protection from Lightning during 1905," is probably epoch-making in the regard which operators at large will henceforth give to this matter. It should not be understood that the report is perfect, because it still leaves much to be desired, but in its essential features there is much of value.

From this report we find that approximately fifty per cent of the companies affected suffered no damage whatever by lightning; twenty per cent had losses confined solely to lightning arresters and meters, so that the remaining thirty per cent—let us say one-third of the companies—suffered serious loss thereby. The total power is represented by 269,695 kilowatts, of which the foregoing percentages are not exactly but fairly closely matched by a slight change in proportionate loss; those not losing any apparatus being thirty-one per cent of the total output, those losing only lightning arresters and meters twenty-eight per cent, while those having heavy losses represent forty-one per cent. This last fact, coupled with the fairly large percentage of number of companies, throws a most important light at the very outset of the report on the performance of lightning protective apparatus. Let us examine further:

Over half of the stations were equally divided in three groups between 200 and 990 kilowatts output; the remainder is found about equally divided among five groups ranging from 1,000 to 5,000 and over kilowatts output, distribution voltages of 110 to 700 and 2,000 to 2,500 volts having a strong representation. Some of the companies evidently distribute at low voltage by means of lowering transformers from high-voltage transmission, ranging in this case from 3,500 to 55,000 volts, the largest number apparently operating at 10,000 to 13,000 volts. It seems at first sight surprising to find but a few companies operating with direct current—ten against eighty-two at sixty cycles; these must be as rare as the sixteen plants at 125 to 140 cycles. Three-phase service is used the most. In any of these cases there is no way of telling in the report as to which service is more vulnerable.

Of the types of apparatus in use the General Electric Company and Westinghouse Electric and Manufacturing Company predominate; the Stanley, Garton-Daniels and miscellaneous types being collectively about fifty per cent of either of the first two. From the method of tabulation it is impossible to say what particular types failed mostly, for it scarcely needs mentioning here that both the General Electric and Westinghouse companies manufacture several types according to the voltage of the system for which protection is required. The returns show, however, high percentages of failure and total loss, irrespective of type.

The employment of choke-coils does not show any special gain; in fact a bare analysis of the figures would indicate that it was more satisfactory not to use them, which seems incredible. Comparatively very few companies use overhead grounded wires, although the reduction therefrom in total loss, according to the table, seems most attractive. It should not be forgotten that all the foregoing values are based on companies, not upon the accounts of actual apparatus. This fact really changes the aspect of the report very materially, because it might be easily possible that the relative loss to one plant would not be as great as in another. Moreover, other conditions unnecessary of mention here might seriously affect the meaning of these indications if we take them as they stand. They are, however, valuable and even significant, because of the general idea which they give as to lightning protective apparatus practice throughout the country. A more direct result would have been obtained by referring to types of protective apparatus and the actual losses occasioned by their failure.

Of the apparatus injured in 1905 lightning arresters head the list with 107 companies total, reporting; transformers, meters, armatures and oil switches following successively in the order of extent of breakdown—the latter two being relatively insignificant in number. It would be interesting to compare this experience with that of street railway companies, where doubtless armature failures from this cause would make a greater showing. The larger proportions of transformers and meters follow naturally from the general disposition of such apparatus on the system. The natural inductance or resistance to static disturbances of nearly all measuring instruments, and the fact that they are often unprovided with choke-coils ahead of them, permits the disturbance to reach them, and lacking proper protection be thrown off by way of the case to ground. It is also probable that the failure of many lighting transformers arises from their exposed locations without full protection. In this connection it would have added to the interest of the report to state how often primary fuses are blown by lightning disturbances without any other consequence than interruption of service.

Of the special items of interest reported on it is found that a large majority of the plants did not suffer from shutdowns due to too violent discharges or to arcs holding on in the arresters. Moreover, almost as great a number of companies report no damage from this cause. There seems to be little criticism of the arresters failing to discharge. The poles and insulators destroyed by lightning discharges have affected approximately twenty-five per cent of the companies, although the total number of poles destroyed is about 100, while only twenty-two insulators are reported broken from this cause. It seems to be agreed that damage is done most frequently by severe storms, although the lines are thought by a large majority of operators not to be affected at a distance from the centre of the storm. Unfortunately, this opinion is interesting as showing a state of mind, but it is doubtful if there is as yet much positive evidence on this point. It is curious and pertinent to the record to observe that the number of times plants have been disturbed by sudden change of load or short-circuits is greater, nearly 100 per cent, than those reported from lightning directly. Moreover, a large proportion, thirty-nine per cent, of these companies suffered a shutdown—a fact which is often lost sight of in discussing lightning-arrester operations. A large majority of operators, however, did not consider the damage therefrom serious.

One of the amusing results of the canvass is to find that although some plants have had no trouble from lightning they do not consider their lightning protection satisfactory. On the whole, the expression for and against seems equally divided.

Aside from the direct loss due to failure of lightning arresters no serious criticisms can be made against them under the circumstances, because in so failing they may have saved much valuable apparatus. It is a characteristic, however, which should be eliminated more and more, because of the danger to which such a failure exposes a plant as a whole. Aside

from this the large number of failures of protective apparatus with attendant loss suggests forcibly the need of improving arresters or modernizing such installations in order that the protection may be the best obtainable. No mention is made of the methods of protection followed—the methods of grounding, the frequency of inspection, etc., all of which show that operators to be successful must go further than this to make such a report effective and indicative of the true weaknesses of modern lightning protective apparatus.

In addition to the foregoing report, certain other recent investigators in this field merit special mention. These are: Messrs. Wirt, Creighton, Osgood and Smith, who have contributed, respectively, through the channels of the American Institute of Electrical Engineers, very interesting data as to the performance of a new design of lightning arrester, its behavior in practice, and in the case of Smith, an important discussion of auxiliary protective apparatus for transmission lines against direct stroke. It would be impossible to go into these cases in detail, and mention is made here to show principally the fact that not only is the manufacturer still actively engaged in this work but that he has been joined by the operator, who has taken to investigation on his own account. In fact, in the cases spoken of by Smith, the transmission service was effected by direct strokes of lightning to such an extent that something had to be done. The manufacturing companies, apparently, could give no assistance, because their apparatus was intended solely for the protection of generating apparatus within the stations, so a cure had to be sought elsewhere.

Although the protection of transmission lines has been considered tentatively for several years, it has been only within the last year or so that the subject has reached an acute stage. This arises from the fact that whereas the long transmission lines on the Pacific coast were relatively free of lightning, those in the East are not, and therefore it might be said that for this reason the longer the line the more the disturbance to be expected from this source.

It is safe to say that the problem is now once for all strictly defined. It consists of two parts. First, station protection; second, line protection. The investigation of the former will doubtless remain for some time largely in the hands of interested manufacturers, the latter in the hands of operators. The service performances of both must, however, be investigated by the operators.

A concerted interest in this subject, together with the cooperation of the United States Weather Bureau, or a use of its methods, can undoubtedly effect great results. It may not be a surprising result if the larger systems, at least, maintain hereafter a special lightning-arrester department of their interests, wherein a vigilant record will be kept, not only of the operation of the protective apparatus, but also an account of its original cost, maintenance and expense involved through its failure.

It is not the purpose of this article to prophesy what the future will offer in protective apparatus, because that must be a matter of evolution. It should be clear, however, that the result attained will be materially affected and perhaps hastened by a vigorous inquiry persistently maintained. It has unfortunately been, heretofore, a subject arousing picturesque discussion. The dignity of its relation to operations in general merits more consideration, and it is safe to say that there is hardly any branch of the sciences in which general observation can be more successful.

Electric Power from Southern Waterfalls.

By J. W. Fraser, Assistant Chief Engineer, Southern Power Company.

ABOUT 10,000,000 spindles, using approximately 300,000 horse-power, are now in operation below the Mason and Dixon line. Less than one-third of this is furnished by water power, while something like 2,000,000 horse-power is still undeveloped in the very heart of the cotton field, and in a climate where ice can not materially affect this development. From a casual review of the situation it would seem that the South has been a little slow in developing this natural resource, but on second thought it appears that this slowness may prove beneficial in the long run. For under the more scientific treatment which it is now possible to bring to bear on the problems involved, the advance may be more rapid than it would have been had the development begun earlier. However, this may be, it is evident to every Southerner that a few years will see an enormous development of water power in the South.

Previous to 1894 mechanical drive was used in all water-power developments, and until within the last two or thee years the hydroelectrical developments were mostly local in scope, furnishing power to a few mills in the immediate neighborhood of the power plant or at the end of a comparatively short transmission line. But the indications at present are that the next ten years will produce networks of systems extending over hundreds of square miles and rivaling in amount of power transmitted any of the great northern or western systems.

Several large plants are now under construction, but before calling attention to the progress of this work let us review the water-power situation since the introduction of the electric drive.

On June 27, 1894, the hydroelectric plant of the Columbia Cotton Mills, Columbia, S. C., commenced operation. This event marks the first milestone in the development of large water powers in the South. I say "large" because of the fact that a great many small streams had been utilized for the direct drive of all kinds of mills and factories, but on account of the drive not being adapted for large mills, small powers were developed in preference to large. Further, this was the first textile mill in the world to be equipped throughout with electric drive, and up to this time the feasibility of transmitting power by any other means than gear, belt or rope was thought impracticable by the mill engineer, and much credit is due to the pioneers who led the way to what must prove such an asset to the South. The distance of transmission in this case was only 800 feet, and a voltage of 570 was sufficient.

Another important step in advance was made when the Anderson Water, Light and Power Company, of Anderson, S. C., began the transmission at 5,500 volts, of 175 horse-power in the latter part of 1895. This power was used for pumping the water supply of the city of Anderson and for light and motors. The development was at High shoals, on the Rocky river, six miles from Anderson, and marks the second milestone—the first long-distance power transmission in the South. Three years later this company developed Portman shoals on the Seneca river and transmitted its output of 1,200 kilowatts to Anderson, a distance of ten miles, at 10,-

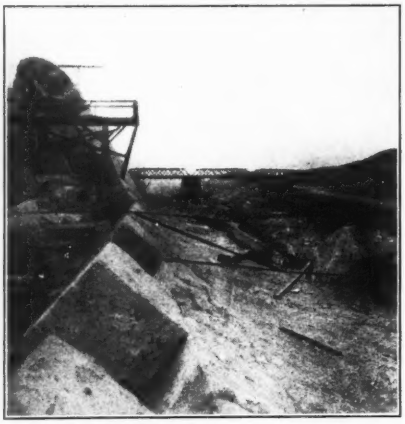
000 volts. Later this output was increased to 4,500 kilowatts.

Almost on a par with respect to date and on a much greater scale than the first development of the Anderson Power Com-

THE DAM ON THE YADKIN, WHITNEY DEVELOPMENT, NORTH CAROLINA.

pany was that of the Pelzer Manufacturing Company, on the Saluda river; this plant was put in operation in the early part of 1896 and transmitted 3,000 horse-power three miles at 3,300 volts, three-phase to Pelzer. This output was afterward increased to 5,000 horse-power.

The next plant was that of the Fries Manufacturing Company, at Winston-Salem, N. C., where 1,000 horse-power was transmitted from the Yadkin river to Winston-Salem, a distance of thirteen and one-half miles, the latter part of April, 1898. This was the first transmission plant in North Carolina.



SPILLWAY AT THE WHITNEY DEVELOPMENT, NORTH CAROLINA.

About the same time the Columbia Water Power Company completed an installation of 3,000 horse-power (which may be increased to 10,000), making a total of a little over 5,000 kilowatts in generator capacity installed in the South before the close of the century.

Other plants of over 1,000-horse-power capacity completed since this date are the following:

The plant of the Montgomery Water Power Company, at Tallassee falls, on the Tallapoosa river, nine and one-half miles from Milestead, which, although under construction, was not completed until 1902. Its output of 5,000 kilowatts is transmitted to Montgomery, twenty-seven miles, at 30,000 volts and used for light and power.

Atlanta Water Power Company's plant, at Morgan falls (Bull Sluice), Ga., on the Chattahoochee river, eighteen miles from Atlanta. It was begun September, 1902, and completed October, 1904. The output of 10,500 kilowatts is transmitted to Atlanta at 22,000 volts, and after being transformed to 6,600 volts is disposed of to the Georgia Railway and Electric Light Company.

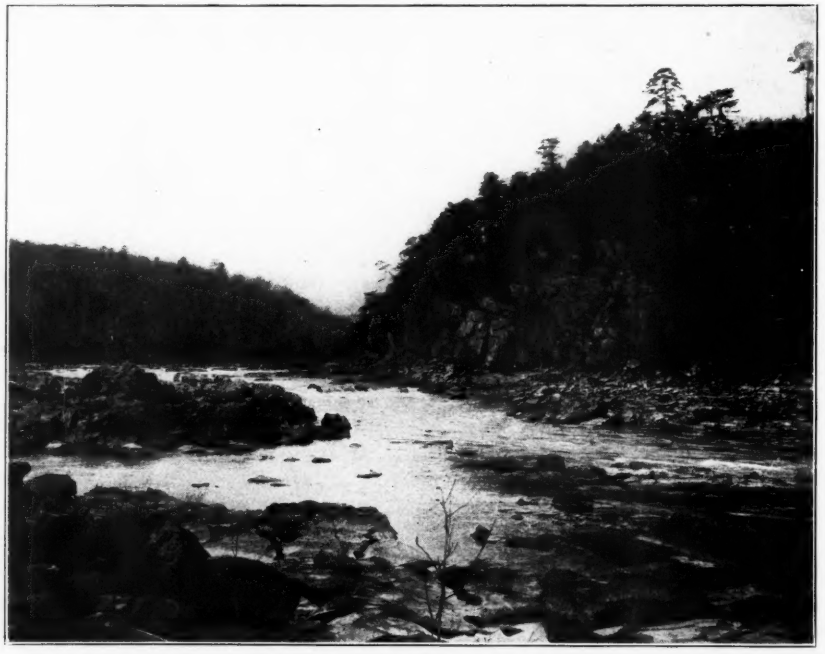
The Columbus Power Company's plant, on the Chattahoochee river, just north of the city limits of Columbus. Two power-houses were built, one to supply 3,000 horse-power direct from the water-wheels to the cotton mills by means of rope drive, and the other to supply commercial electric power. In the latter is installed five 1,080-kilowatt, sixty-cycle, two-phase, 6,000-volt generators, the output of which is used by the various cotton mills and other industries of Columbus.

The Weaver Power Company's plant, on the French Broad, near Asheville, N. C., where two 750-kilowatt generators are furnishing power for commercial service in Asheville. (Provision has been made for four.)

The North Georgia Electric Company's plants, one at Gainesville, Ga., on the Chattahoochee river, above the Atlanta Water Power Company's plant, and another at a shoal four miles below Canton on the Etowah river, with a total of 4,000 horse-power. This power is transmitted to Atlanta on a forty-two-mile steel transmission line at 40,000 volts.

The Union Power and Manufacturing Company, on the Broad river (a tributary of the Congaree), with a total capacity of 7,000 horse-power.

The Catawba Power Company's plant,



THE NARROWS OF THE YADKIN AT THE WHITNEY DEVELOPMENT, NORTH CAROLINA.

at India Hook shoals, on the Catawba river, seven and one-half miles from Rock Hill, S. C., and eighteen miles from Charlotte, N. C. This plant commenced operation in March, 1904, with three cotton mills and a small lighting load. This amounted in all to 900 horse-power, and to-day it is driving fifteen cotton mills—a motor load of 8,000 horse-power for eleven hours per day, and a peak load of 10,000 horse-power, the maximum capacity of the plant.

The Dan River Power and Manufacturing Company's plant, on the Dan river, about two miles above Danville, Va. The flow of the river at this point, with a twenty-five-foot head, gives 4,000 horse-

power, which is utilized to drive a large cotton mill.

The Belton Power Company's plant, on the Saluda river, eleven miles below Pelzer, with a capacity of 5,000 kilowatts. This power is transmitted to Belton, S. C.

The Ware's shoals, on the Saluda river, sixteen miles from Greenwood and twenty-four miles from Anderson; capacity, 3,000 horse-power.

WHEEL CASING OF 5,200-HORSE-POWER TURBINE, GREAT FALLS STATION, SOUTHERN POWER COMPANY.

The Virginia Passenger & Power Company's plant on the James river at Richmond, Va. This plant is designed for an ultimate capacity of 10,000 horse-power in twin turbine units of 1,200 horse-power each, seven of which have been installed. Turbines are direct connected to 700-kilowatt generators.

The above comprises all or nearly all the hydroelectrical developments of 1,000 horse-power and over now in operation in the South. The growth has certainly not been rapid, but these few scattered plants have paved the way for the many large developments now under construction or projected. The projected plants are so numerous that it is beyond the scope of this article to refer to them, and it will only be necessary to outline some of those actually under construction in order to give some idea to the extent of this development.

We shall refer first to the work now under way above the narrows on the Yadkin river, about sixty-five miles above the South Carolina state line, the most famous water power in North Carolina. Preliminary work was commenced on this plant about four years ago by the Whitney Company, under the general management of the late E. B. C. Hambley, vice-president. A head of 129 feet will be obtain by the completion of a dam 1,000 feet in length and thirty-eight feet in height and a canal four and one-half miles in length. The hydraulic equipment will consist of six vertical turbines of 9,000 horse-power each, only five of which will be installed at first. It is intended that the generators will be direct-connected and will give an output of 25,000 kilowatts at 11,000 volts, three-phase, sixty-cycle, but the electric equipment has not yet been decided upon. The canal will be forty feet at the bottom, 112 feet at the surface of the water and eighteen feet deep. The canal spillway will be 1,400 feet in length. Coursed face masonry is used for both faces of the dam and the river face of the abutment and spillway. The interior of all masonry structure is constructed of large irregular undressed stones, filled in with concrete. From one-half to two-thirds of the dam and canal are completed. Somewhere about 25,000 additional kilowatts are available on the same river within the boundaries of the land owned by the Whitney company.

Within a radius of eighty miles of this plant there is enough power used in cotton mills alone to absorb the total output of both developments. But the company purposes to induce manufacturers to locate in the immediate neighborhood, where it has holdings to the extent of 14,000 acres.

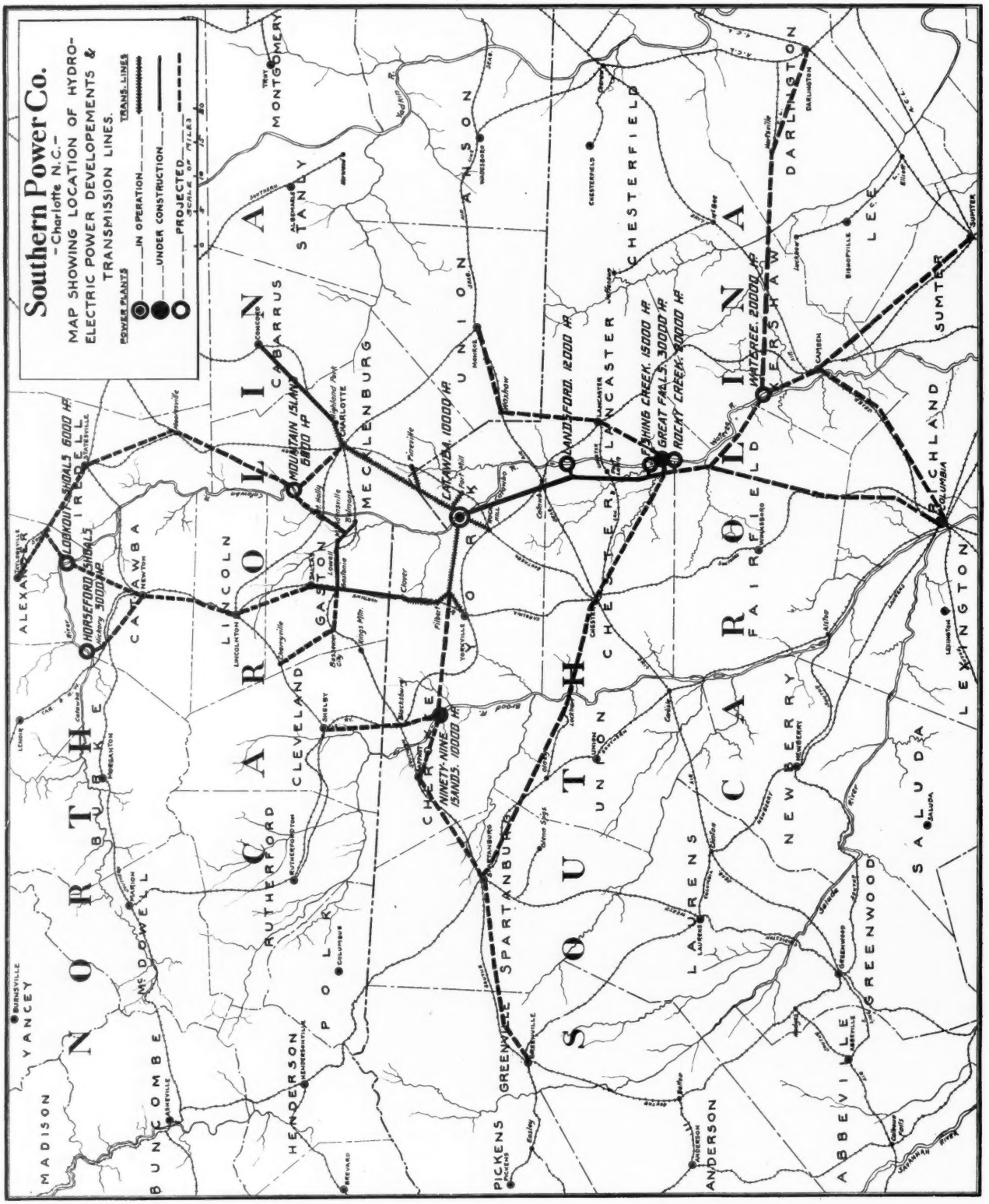
Another large plant under construction is that of the Chattanooga & Tennessee River Power Company, thirty-three miles below Chattanooga, at Hole's Bar. The dam will have an average height of fifty-two feet, will give a head of thirty-nine and one-half feet at low water, and will back the water to Chattanooga. The variation in volume of water runs from about 5,000 cubic feet per second to 250,000 cubic feet per second, and the minimum average flow for two months in the year is about 8,000 cubic feet per second. Designs for the electric equipment have not

DAM AND HEADGATES FOR TURNING RIVER INTO CANAL, GREAT FALLS STATION, SOUTHERN POWER COMPANY.

yet been completed, but it is expected that this site will develop in the neighborhood of 50,000 horse-power. This company was organized about two years ago by C. E. James and J. Guild, of Chattanooga, and it expects to complete this plant by the end of next year.

I have already referred to the North Georgia Electric Company in the list of completed plants as owning and operating one plant on the Chattahooche river and another on the Etowa river, and it should be noted that this company, under the direction of General A. J. Warner, has acquired several other powers which it expects to develop.

The Rockingham Power Company has also commenced the construction of a large plant at Bluitt falls, on the Peedee river, near Rockingham, N. C. A head of fifty feet will be obtained by backing the



MAP SHOWING THE LOCATION OF THE HYDRO-ELECTRIC POWER DEVELOPMENTS AND TRANSMISSION LINES OF THE SOUTHERN POWER COMPANY.

water six miles. This will require a thirty-eight-foot dam 1,650 feet in length, and it is estimated that this will give a capacity of 28,000 horse-power, but only 12,000 horse-power will be developed at present.

Some other smaller plants are that of the Savannah River Power Company, at Gregg and Cherokee shoals, on the Savannah river, near Anderson—6,000 horse-power; Spencer Mountain Power Company, on the South fork of the Catawba river—3,000 horse-power; Electric Manufacturing and Power Company, at Nesbit's shoals, on the Broad river—5,000 horse-power for transmission to Spartanburg, S. C.; Saluda River Power Company, five miles from Greenville. Here in 500 yards the river has a fall of sixty-four feet, which will give about 3,000 horse-power.

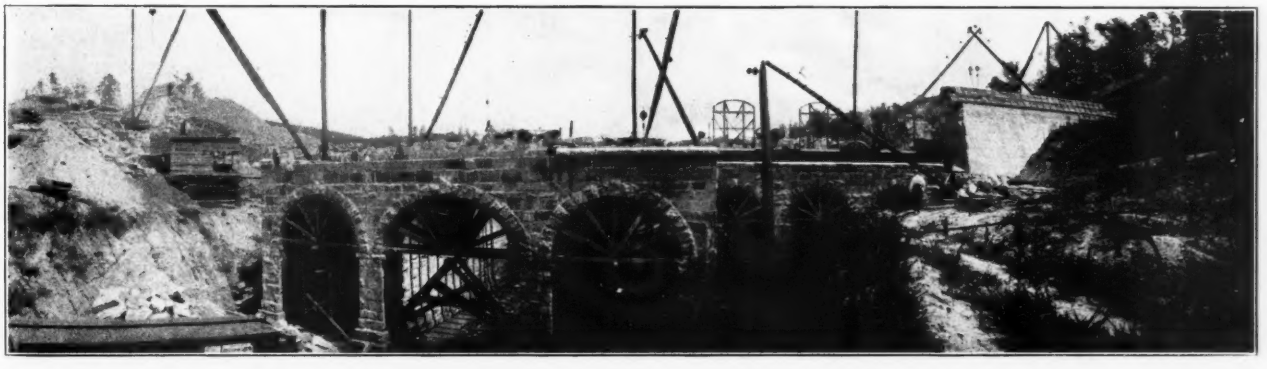
Dam and Headgate for Turning River into Canal, Great Falls Station, Southern Power Company.

In a preceding paragraph I referred to the quick sale of the total output of the Catawba Power Company's plant, near Rock Hill, S. C. This company by its practical distribution of power has gained the confidence of the mill owners of that district and furnishes power to fifteen cotton mills within the radius of twenty miles of the plant. The Catawba Power Company was financed by Dr. W. Gill Wylie (president), who was a pioneer in long-distance transmission in the South, having been connected with the Anderson Water, Light and Power Company from its organization. The great demand for power in the immediate neighborhood of the Catawba station led Dr. Wylie to consider the advisability of developing other plants in different parts of the country, with the result that a company was formed with Dr. Wylie as president (with a capital of $7,500,000) to acquire and develop a sufficient number of water powers to furnish power to a section of country 160 miles in length and sixty miles in breadth in the heart of what is know as the "Piedmont region," the richest and most fertile section of the Carolinas. This section is dotted with cotton mills throughout its length and breadth, and over 150,000 horse-power is used, generated mostly by steam.

Eight undeveloped water powers on the Catawba river, besides the Catawba station, were taken over, and one on the Broad river. The water rights cover a distance of 110 miles on the Catawba river and form an aggregate head of 500 feet; in all, about 150,000 horse-power. The advantages obtainable from this control of water rights are very obvious to the hydraulic engineer. The flow of water can be regulated from one plant to another and from one storage to another to suit the demand at different points on the network of transmission.

And as this company is leaving no stone unturned to make its whole system as modern and up to date in every respect as possible, we shall describe in some detail the work now in progress.

Hardly was the company formed when preliminary work was commenced at Great Falls, S. C., fifty miles below Charlotte and fourteen miles above Camden. This site was selected because of a possibility of quick development. There is a total fall here of 175 feet in seven miles and the choice of either two or three developments. However, it was found by turning the river into a natural canal about the middle of the shoal and building the power-house and main dam (or bulkhead wall) 6,000 feet further down a quick development could be made with a head of seventy-two feet. As this plan did not interfere with the other developments and promised to be the least expensive method of dealing with the situation it was de-



Power-House, Great Falls Station, Southern Power Company. Transformer House in Front. From Bottom of Foundation to Top of Bulkhead Wall, 105 Feet.

cided upon, and work was commenced at once. It was necessary to build a branch railroad, twelve miles long, in order to facilitate the movement of cement and machinery. Surveys were commenced on railroad and dam site in May, 1905, and the first stone was laid at the dam on February 2.

Contracts already signed made it necessary that this plant be in operation by January, 1907, and at this writing everything points to its completion by that time. The dam and head-gates to the canal are two-thirds completed and the greater part of the power-house bulkhead is placed. The draught tubes and water-wheel casings are nearly all set and the transformer house is well under way.

The electric problems involved in this proposition are somewhat different from any other comparable in size with it. The Niagara system receives power at one point and distributes to the surrounding country; the California Gas and Electric Company feeds, always in one direction, from a number of other points into one great reservoir (with a few small exceptions), but the power to operate the immense network of lines that will be necessary for this system will be taken in at various points in the neighborhood of distribution and may be fed in any direction from any one of these points. This will be better understood by examining the accompanying map.

Another problem was how to arrange for the variation of voltage necessary for a station that might be feeding into an immediate neighborhood at one time and feeding into a system sixty miles distant a few hours later. This was arranged for by having the generators, transformers and complete station apparatus designed capable of carrying continuously a fifteen per cent increase in voltage.

Taking into consideration the amount of country to be covered, it was desirable to have the transmission voltage as high as practicable; against this was the fact that the larger part of this power would be tapped off at a great many cotton-mill substations having a capacity of from 250 to 750 horse-power. After calculating the copper loss for an assumed (probable) distribution, 44,000 volts was decided upon as an electromotive force most suitable for this system. This worked in well with the pressure of the Catawba station, which is 11,000, and the installed transformers on the Charlotte lines, which are wound for 11,000 and 22,000 volts.

In the Great Falls station there will be eight 3,000-kilowatt, three-phase, 2,200-volt Westinghouse generators, direct-connected to six horizontal turbines of the Escher-Wyss pattern made by the Allis-Chalmers Company, and two Hercules turbines made by the Holyoke Machine Company. The 400-kilowatt, 250-volt exciters will each be capable of carrying the total exciting current.

The plant is so designed that two generators and their three transformers will form a complete unit, which, if necessary can be entirely separated electrically from the other units. All transformers will be in separate compartments and will be mounted on trucks. Both the high and low-tension switch structures will be in separate rooms. Low-tension switches will be Westinghouse type "C," and high-tension, type "G." Instrument pedestals to control stands will be arranged in a semicircle so that the operator can see all meters without moving. A bench-board was not deemed advisable to meet conditions.

The main transmission line will connect this plant with the Catawba station at Rock Hill, S. C., thirty-two miles distant, where a transformer station is being built to step up the voltage of the Catawba plant from 11,000 to 22,000 and to step down that of the main transmission line to 22,000 to feed the Charlotte division. It will also connect with Gastonia and Concord. Proposed connections can be seen by inspecting the map.

Steel towers will be used for all main lines of transmission. The first 600 under order are now being shipped and will be erected as soon as received. They will carry two three-phase circuits of No. 000 seven-strand hard-drawn copper and two grounded wires above the transmission cable. Besides this lightning protection, both horn and water arresters will be used. Surveys for these towers have been completed, and most of the feet have been concreted in position ready to receive the superstructure.

Transformers for substations, whether purchased by the Southern Power Company or by consumers, are being built under standard specifications and of selected size, so that in case of breakdown a new transformer can be quickly substituted for the damaged one.

Several new features have been incorporated in the power-house and transmission line design which will be described in a more detailed account of this system.

Small Railway Substations.

By W. L. Waters, Chief Engineer, National Brake and Electric Company.

THE conditions of operation, and consequently the equipment of railway rotary-converter substations, vary so widely that we can hardly consider all such substations as coming under one broad class. We have substations such as those on the Interborough system in New York city, each station containing six or eight 1,500-kilowatt units and carrying a practically steady load. And we have small interurban substations with perhaps two 100-kilowatt units carrying a load which at times fluctuates violently.

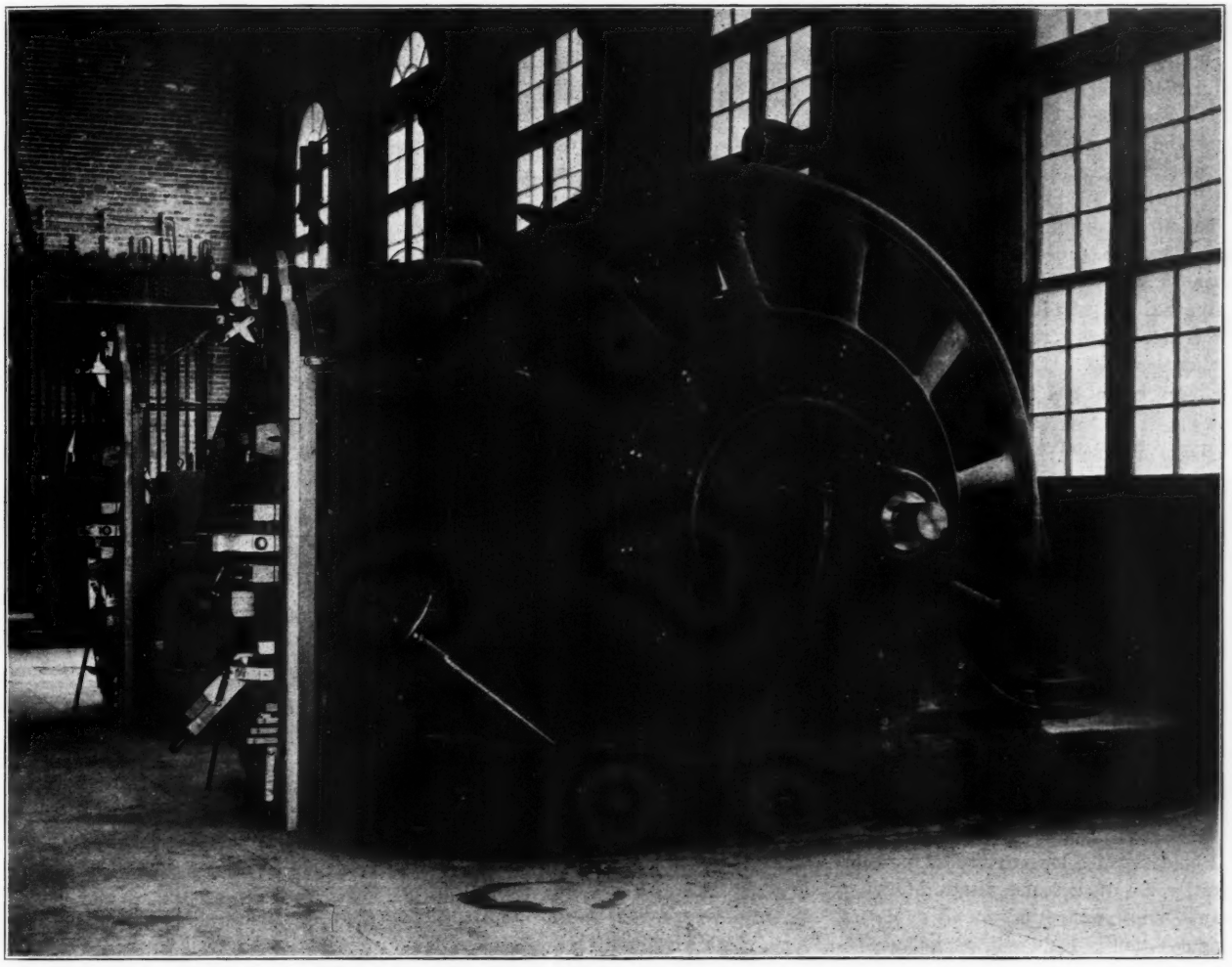
The first-mentioned type, the high-power substation for city work, operates under the most favorable conditions. Usually no expense is spared in regard to equipment. A sufficient number of rotaries are installed to carry the load easily even under extreme conditions. Auxiliary motor generators or induction motors are provided for starting the rotaries, and probably a storage battery is provided to help out on heavy overloads. The switchboard is conveniently located in a gallery and equipped with remote-control oil switches, time-limit and reverse-current relays, and all the modern refinements for controlling a high-power station. The attendant in charge of such a station is highly trained and capable, and the supervision and operation of the machinery is usually as perfect as can be expected. The only danger for such a station lies in the immense reserve power in the main generating station, and in the capacity and low resistance of the high-tension cables and in the low resistance of the direct-current feeders. The combined effect of these may produce disastrous results in the case of short circuits or careless manipulating of switches, or in the case of the small breakdowns or failures of equipment that are certain to occur occasionally in any system.

Contrasting this with the small interurban station, the difference is very great. In such small stations the first cost of the

equipment has to be reduced to an absolute minimum. The switchboard equipment is incomplete, the rotaries are often heavily overloaded, and the attendants and supervision in the station are usually very unskilled. The reserve power is not so great and the resistance of the feeders is higher, so that the results of mistakes in operation and breakdowns are not so disastrous. But the treatment the equipment gets is usually so bad that it is a much more severe test for the machines than is ever put on the larger station.

The small or interurban type of substation can usually be considered as having an output of less than 1,000 kilowatts in units of 100 to 500 kilowatts. When laying out such a station the main thing usually considered is economy in first cost. The power is generally transmitted to such a station by means of overhead feeders. This means a probability of more or less lightning trouble. Lightning arresters are provided, but no particular care is used in their selection, the cheapest being usually installed. This means that oil-insulated transformers are a necessity, and as a water supply can not usually be obtained for cooling purposes, self-cooling transformers are practically always used. The usual arrangement of switch-panels is to have the complete switchboard at one side or one end of the station. In this position the operator has his back to the machines when operating switches. A variation from this arrangement is shown in the illustration herewith. The rotary panel in this case is located at the side of the machine and so arranged that the operator faces the machine when operating switches. This design is due to O. M. Rau, chief electrician of the Milwaukee Electric Railway and Light Company, and has the advantage that the operator can watch the rotary at all times. It is, however, slightly more expensive than the standard layout. The switchboard equipment in small substations is always the simplest that will handle the equipment. Oil switches on the high-tension side are seldom installed. The transformers are connected direct to the high-tension mains by means of disconnecting switches, these switches being capable of breaking only the no-load current of the transformers. In case of trouble on the high-tension side the power station is instructed by telephone to disconnect the substation feeder.

The characteristic feature of the load on a small or interurban rotary substation is the violent fluctuations that take place. The car service is infrequent and the station normally carries a light load, the load being distant from the substation and being partly carried by other substations. But at intervals we get suddenly thrown on the station the load of starting one or two cars or trains. This usually heavily overloads the station for a short time, and then the load gradually drops back to normal. The most suitable way of dealing with such heavy loads depends somewhat upon the layout of the system. If we have a long line with a number of substations and with all the trolley sections



SUBSTATION, MILWAUKEE ELECTRIC RAILWAY AND LIGHT COMPANY.

tied together and paralleled by feeders, we get the best arrangement by using shunt-wound rotaries, standard transformers and no reactance coils. As the load comes on any substation we get an increasing drop in the alternating-current feeders and in consequence a lower alternating-current voltage at the station. And as the ratio of the voltage on the direct-current side of the rotary to that on the alternating-current side is constant, this means that with shunt-wound rotaries we get a direct-current voltage which falls as the load comes on the station. The voltage will probably be about 650 with no load, falling to about 550 for overloads. With such a system consisting of a number of substations tied together, this gives the desired result that the lightly loaded stations running at higher direct-current voltage tend to help out the heavily loaded stations running at lower voltage. This prevents the whole of the heavy load coming on one station and enables us to make our substations of smaller capacity. If, on the other hand, we have conditions in which one substation feeds a long line, then shunt-wound rotaries would not be suitable. Because in this case we must have the direct-current voltage at the station rise as the load comes on in order to compensate for the increased drop at the end of the long direct-current feeder. In this case we should install compound-wound rotaries and reactance coils. By suitable adjustment of the compounding of the rotaries and of the reactance coils we can get the desired rise in the direct-current potential as the load comes on the station. In this case the direct-current voltage would probably be arranged for 550 volts at no load, rising to 650 volts at full load. It would take too long to discuss the comparative advantages and disadvantages of shunt and compound-wound rotaries. This question is dealt with in the author's paper on "Synchronous Converters for Railway Work," read before the annual convention of the American Institute of Electrical Engineers, May, 1906, and the reader is referred to that paper for further and more detailed information. The compounding of rotaries is a great advantage in the one case in which we sometimes have a heavy load to be carried at the end of a long direct-current line or feeder. Otherwise this method of compounding rotaries is not so satisfactory as would be expected, the system being quite complicated and much less under control than in the case of shunt-wound rotaries. And as the ability of the attendants employed in such substations is usually quite limited, it is always a great advantage to have everything as simple as possible.

The usual way of starting rotaries in a small substation is from the alternating-current end by means of half-voltage taps on the transformers. The rotaries are run up to speed, the field circuit is closed, and the polarity and voltage tested by means of the voltmeter and the machine then thrown on the direct-current line. This method is much preferable for such substations to that of starting from the direct-current side, because the direct-current voltage is usually fluctuating anywhere from 300 to 500 volts. In consequence, the speed of the rotary running as a direct-current motor varies rapidly, and often the alternating-current frequency fluctuates at the same time so that it becomes impossible to even attempt to synchronize. The result often is that the attendant finally gets tired of trying to synchronize and throws the machine in when the speed is very different from synchronism. The rotary then flashes over and has to be pulled off and started again.

One of the chief requirements of the equipment in such a substation is ability to carry sudden and extreme overloads. Fortunately rotary converters, when well designed and liberally rated, are capable of carrying easily quite heavy overloads. And standard rotaries are, or should be, rated so that they will carry about three times full load for sixty seconds without flashing over. The transformers will of course carry heavy overloads if they are not long continued. The usual mistake made in considering the overload capacity of such a substation is that too small a circuit-breaker is provided. The usual rotary-converter circuit-breaker is capable of breaking only double the normal rated capacity of the rotary, and this circuit-breaker is generally set for fifty to seventy-five per cent overload on the rotary. The attendant soon finds out that the rotary will carry without danger considerably heavier overloads and that the circuit-breaker opens quite frequently. So the result is that the automatic attachment is finally removed from the circuit-breaker, and any overloads or short-circuits are left on the station till the circuit-breaker is tripped by hand. This is very bad practice, as a sudden or continued short-circuit, or a sudden opening of the field circuit, or throwing the rotary on the line badly off synchronous speed, will practically always cause a rotary to flash over and damage the brush gear. A circuit-breaker should be provided capable of being set to open at three or four times the full load of the machine. This circuit-breaker should be set so as to open at three to three and a half times full load on the rotary, and then the machine left to take care of itself. Anything less than about three times full load the rotary can pull, and anything greater than this should be taken off as soon as possible.

One of the most important items in the operation of a small rotary substation is the cost of attendance. This is such a large proportion of the total cost that it is always cut down to a minimum. This means that the station is usually operated with cheap and incompetent men, and this is very severe on the equipment. We find substations of 500 to 1,000 kilowatts capacity in charge of boys who have had absolutely no experience. They soon become accustomed to the routine work in a station and do fairly well as long as nothing unforeseen happens. But when anything happens slightly out of their routine they either lose their heads or are at a loss what to do, and generally do the wrong thing. They start up a compound-wound rotary from the direct-current side without first short-circuiting the series winding. They start from the alternating-current side, and, finding perhaps that the fields do not excite, they decide to throw it on the direct-current line anyhow in the vague hope that the fields will then excite and the rotary take its share of the load. They start from the direct-current side and then close the alternating-current switches regardless of the speed of the rotary. These are only a few of the things that happen every month in a small rotary-converter station with this kind of attendance. And when the manufacturer hears that a rotary of his own or of a competitor's make has burned up in one of these stations his only surprise is that it has run as long as it did. It is much better to have no attendant at all than to have such boys in charge of a station. Send a competent man to start up the substation and see that everything is operating satisfactorily, then set the rotary circuit-breakers for three to three and a half times full load and leave the station to take care of itself, only sending a man perhaps two or three times a day to see that everything is operating satisfactorily. In this way a single competent man can operate half a dozen substations with much better results than could be obtained by incompetent men permanently in each substation. The worst that could happen would be that a short-circuit would cause a circuit-breaker to open and cut a substation off the line. And in all probability the other substations or the power-house could in this case

pull the load at a lowered voltage till the short-circuit was cleared and the rotaries put on the line again.

Small rotary substations for railway work operate probably under worse conditions than any other class of station. The conditions imposed by the first cost of the station, by the nature of the load, and by the handling the equipment gets, makes this class of work the severest possible test of the design of the station and of the machinery in the station. Competition has reduced the price of the equipment to a minimum, and there is a great temptation for the manufacturer to rate his machines very closely. It is usually impossible for the operating engineer to know just what will be the capabilities of the machinery he is buying until he actually has it in operation. So considering everything, it is quite remarkable that such uniformly good operation is obtained from these substations, and it is certainly greatly to the credit of the operating engineers and manufacturers. The only improvements that may be looked for in the near future are in the direction of closer standardization of voltage and equipment. When this has been done and when the operating engineer and manufacturer have got a little closer together in coordinating the design and operation of the machinery, the small railway substation will rank second to none as an example of first-class engineering results obtained under very difficult conditions.

Report of the British Association Committee on Practical Standards for Electrical Measurements.[1]

In the last report reference was made to a conference of representatives of standardizing laboratories which had been invited to meet in Berlin as a preliminary to the more formal conference on electric units suggested at St. Louis. The question of this preliminary conference was brought before the committee at a meeting on October 19, 1905, and attention was called to the importance of clause 2 of the provisional programme—*viz.*, "Shall the three units, the ohm, ampere and volt, be defined independently, or shall only two be defined, and, if so, which?" and it was agreed unanimously that two units should be defined independently, and that these two should be the unit of resistance and the unit of current. The secretary was instructed to report this to the conference at Berlin.

This conference took place in October last at the Reichsanstalt in Charlottenburg, and was attended by representatives from America, Austria, Belgium, England, France and Germany. Agenda prepared with great care by the president of the Reichsanstalt were very carefully discussed, and, as a result, the conference expressed the wish that an international convention should be summoned in order to arrive at agreement in the electric standards which are in use in the different countries.

The following resolution was further adopted:

"In view of the fact that the laws of the different countries in relation to electrical units are not in complete agreement, the conference holds it desirable that an official conference should be summoned in the course of a year with the object of bringing about this agreement."

The conference further expressed the opinion:

1. That the information before it is not sufficient to enable it to propose any alteration in the formerly accepted value for the ampere.

2. That the information before it is not sufficient to enable it to lay down exact directions in respect to the silver voltameter and the standard cell.

3. That if a proposal for a change in the accepted value of the ampere is to be brought from any source before a formal congress to be held later, an agreement in writing on the point should be come to previously between the parties interested. If differences of opinion in the matter can not be removed, a new preliminary conference should be held.

The same procedure should be observed in regard to the specification for the silver voltameter and the standard cell, in the event of such specifications being submitted to a formal conference from any quarter.

The following formal decisions were agreed to:

1. That only two electrical units shall be chosen as fundamental units.

2. The international ohm, defined by the resistance of a column of mercury, and the international ampere, defined by the deposition of silver, are to be taken as the fundamental electrical units.

3. The international volt is that electromotive force which produces an electric current of one international ampere in a conductor whose resistance is one international ohm.

4. The Weston cadmium cell shall be adopted as the standard cell.

Recommendations were also made as to realizing the ohm, and some particulars as to the cadmium cell were agreed upon.

These results were laid before the Board of Trade, and a departmental committee, of which the secretary was a member, drew up a report recommending that an official conference should be invited to meet in London, and it is understood that negotiations are now on foot with view to summoning such a conference.

During the year the work in connection with the absolute ampere balance has been in progress, and is practically complete. Under the supervision of Professor Ayrton and Mr. Mather a large number of determinations have been made, and are most satisfactory. Detailed particulars are reserved until the work is complete; but there is little doubt that the balance is a most excellent absolute instrument, and that the probable error of a determination of current by means of it is only a few parts in 100,000.

The investigation of the silver voltameter has been extended beyond the limits originally thought to be necessary. The results so far obtained are very valuable and appear to indicate that a satisfactory form of silver voltameter is realizable. It is hoped that the publication of the results will take place at the same time as those of the ampere balance.

An appendix (not yet available) by F. E. Smith describes the methods of comparing resistances in use at the National Physical Laboratory, and discusses the sources of error and the accuracy attainable.

The grant of £25 made in 1905 has been expended in materials for the work on the ampere balance and the silver voltameter. In connection with the latter a large amount of work involving considerable expense remains to be done. For this purpose the committee ask for reappointment with a grant of £50. They recommend that Lord Rayleigh be chairman and Dr. R. T. Glazebrook secretary.

[1] This report was issued during the recent meeting at York. The committee consisted of Lord Rayleigh, chairman; Dr. R. T. Glazebrook, secretary; Lord Kelvin, W. E. Ayrton, J. Perry, W. G. Adams and G. Carey Foster, Sir Oliver J. Lodge, Dr. A. Muirhead, Sir W. H. Preece, A. Schuster, J. A. Fleming and J. J. Thomson, Dr. W. N. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Dr. G. Johnstone Stoney, S. P. Thompson, J. Rennie, E. H. Griffiths, Sir A. W. Rücker, H. L. Callendar and George Mathey.

Fuel, Water and Gas Analysis for Steam Users.[1]

By John B. C. Kershaw, F I. C., Analytical Chemist and Electrochemist.

I.—Natural and Artificial Fuels: Their Origin, Composition and Methods of Sampling.

The form in which fuel may be used under steam boilers, in order to produce the heat energy which it is desired to utilize in the form of steam, is exceedingly diverse. Natural fuels are either solid or liquid, but both varieties may, by aid of suitable apparatus and plant, be converted into gaseous fuel. A natural gas which may be used as fuel is also found in certain localities in Europe and America. In the latter country it is largely used for lighting and heating purposes. At the present time there is a decided tendency to employ fuel-gas in place of solid fuel for many purposes in the arts and industries. The control of the combustion process is much more easily carried out when employing fuel-gas than when using solid fuel; and the loss of heat which occurs in the gas-producing plant is to some extent balanced by the value of the ammonia and tar products, obtained by suitable treatment of the producer-gases. The sulphur impurities of the coal may also be removed—and obtained as valuable by-products. Although gaseous fuel has not been applied on any considerable scale to the firing of steam boilers in this country, this method of steam raising will receive increased attention and application in the future; and, in the writer's opinion, the increased use of fuel-gas is likely to prove one solution for the smoke problem which now confronts manufacturers using solid fuels for heating purposes in large cities.

Carbon and hydrogen are the essential heat-producing elements in all natural or artificial fuels. The amount of heat produced by the complete combustion of one pound of fuel depends upon the percentage of these two elements present in the free or combined state. Combustion is in reality an oxidation process. The products of the complete combustion of fuel are carbon dioxide gas (CO_2) and aqueous vapor (H_2O). The incomplete combustion of fuel produces a number of secondary products, chief of which are carbon monoxide gas (CO) and various hydro-carbon gases—methane, ethylene and acetylene; these latter being either present as such in the fuel, or formed by combination of the carbon and hydrogen of the fuel when it is first heated. On further heating, in presence of an adequate supply of air, these gases burn with evolution of heat and production of carbon dioxide gas, or carbon dioxide gas and aqueous vapor. The further chemistry of the combustion process will be dealt with in Article IX of this series. It may, however, be stated here, that the exact nature of the physical and chemical changes which occur when coal is heated is still unknown. Chemists have not yet discovered whether the hydrogen present in solid fuels exists in the free or combined state. Boernstein has recently published an investigation bearing on this subject (see J. Soc. Chem. Ind. 15-3-06, p. 213).

Natural solid fuels may be classified in the following order: Wood, peat, lignite, bituminous coal; semi-anthracite and anthracite; while petroleum and its by-products stand as the representatives of liquid fuels; and coal-gas, coke, peat-coke and briquette fuels represent the artificial derivatives of the above natural fuels.

All naturally occurring solid fuels are held to be modifications of wood and woody fibre; absence of air, heat, and pressure being the agencies which bring about decay and fossilization of the vegetable matter.

Geologists assert that anthracite is the oldest of the natural solid fuels. Cellulose, the chief constituent of wood and woody fibre, is represented by the formula—$C_6 H_{10} O_5$, and contains forty-four per cent only of carbon; while anthracite contains ninety per cent. The process of conversion of wood into coal is thus accompanied by a gradual escape of a portion of the oxygen and hydrogen, which make up fifty-six per cent of the weight of cellulose, and a gradual increase in the density and hardness of the product of this change. Lignite, soft or bituminous coal, and hard or steam coal, are the successive stages in the conversion of wood into anthracite. Peat is a similar product from plant life which grows in bogs, of less age and therefore of less fossilized character than coal. In peat, the percentage of volatile matter which is given off on heating is often as high as sixty-five per cent, and the solid carbon is thus less than one-third of the total weight of the peat. Time, heat, and pressure would no doubt convert peat into a fuel resembling coal.

Petroleum and natural gas are fuels that have been produced by another series of changes in the strata of the earth's crust; but limits of space will not permit of any discussion of the various theories relating to the formation of these products.

Wood—Although wood is not used to any great extent as a fuel in countries with extensive and available supplies of coal; yet as the original material from which our coal supplies have been derived by natural processes, its composition and characteristics deserve some mention here. Wood in its natural state is composed of thickened plant cells, which on microscopic examination reveal three constituents: the woody fibre or cellulose; the sap, and the mineral salts taken up from the soil.

The sap consists chiefly of water, with the organic salts, required for nourishment of the tree or plant, in solution. In freshly felled timber the water present in the sap may amount to forty-five per cent of the total weight of the wood; by air-drying this can be reduced to from ten per cent to twenty per cent according to the nature of the wood and density of its fibres. The woody fibre contains from forty to forty-four per cent of carbon, and is the real heat-producing element of wood. Owing to the large amount of hydrogen and oxygen present in the molecular proportions of aqueous vapor, in cellulose ($C_6 H_{10} O_5$) the thermal value of wood as a fuel is not high. Direct tests have shown that one pound of air-dried wood on the average will only evaporate 4.5 pounds of water. Owing to the low percentage (under one per cent) of mineral matter present in wood, however, after dry distillation has removed the water and other volatile constituents it is one of the purest forms of carbon, and wood charcoal, as the product is called, has an evaporative efficiency more than double that of the wood—from which it is derived. The cost is, however, prohibitive of its use as a fuel on a large scale.

Peat—Peat is formed from plants and shrubs which find their habitat in swampy districts, under conditions which produce decay, in the absence of oxygen or air, *i.e.*, under water.

Owing to the peculiar conditions under which peat is formed, the amount of water and ash which it contains is always high, and these two constituents on an average amount to more than three-fourths of its composition by weight. The following are approximate analyses of typical samples of peat:

	Irish Peat. Air-Dried. Per Cent.		English Peat. Air-Dried. Per Cent.	
Moisture	21.60		20.36	
Ash	2.90	On dry sample	1.30	On dry sample
Coke	27.90		35.00	
Volatile matter.	72.10		65.00	
Fixed carbon..	25.00		33.70	

Air-dried peat still retains from twenty

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per cent to thirty per cent of water, and on this account its value as a fuel is very low. By mechanical and chemical treatment this water can be reduced to from ten per cent to fifteen per cent, and peat in this state then becomes a fuel comparable in appearance and evaporative value to bituminous fuel—though still high in ash.

It is probable that as the coal fields of this and other countries become exhausted, the immense reserves of peat which exist in nearly all countries will be drawn upon, and that by modifications of processes now in use, supplies of peat-coke and peat-fuel will be made available for industrial and household use.

Lignite or Brown Coal—This is a natural fuel intermediate between peat and bituminous coal in age and appearance.

Lignite is formed by the gradual decay of shrubs and trees under conditions which have excluded air and oxidation, but have differed materially from those which have obtained in the formation of peat. The percentage of water present in freshly won lignite is, however, high—varying from forty per cent to fifty per cent—and even after air-drying, twenty per cent of water is still present in the fuel. The ash contents vary from five per cent to ten per cent—while the carbon present ranges from seventy per cent to eighty per cent. Though lignite is not used to any great extent as a fuel in this country, its evaporative value is fairly high. When the deposits of lignite lie close to the works where they can be used, and the cost of cutting and transport are low, this fuel can compete in price and efficiency with the more generally used bituminous coal, and there are many works in Germany using lignite alone for steam-raising purposes.

Bituminous Coal—This is the type of coal employed most generally on land for firing boilers, since it is much cheaper than the anthracite and semi-anthracite fuels, and when burned under scientific conditions, can be used so as to produce high efficiency and little smoke. The following are analyses[1] of a typical bituminous fuel from the Lancashire district; but all fuels containing over twenty per cent of volatile matter come under this classification.

APPROXIMATE ANALYSIS.

Volatile matter ..	29.10 per cent	
Fixed carbon....	58.04 "	70.90 per cent coke
Ash.....	12.86 "	
	100.00 per cent	

[1] From tests made by Dr. Hethrington.

ELEMENTARY ANALYSIS.

	Per Cent.
Carbon	72.60
Hydrogen	4.79
Oxygen	7.28
Sulphur	1.64
Nitrogen	0.71
Ash	12.86
	99.88

The calculated calorific value of this fuel was in round numbers 7,000 pounds centigrade thermal units, equivalent to 12,600 British thermal units. It is interesting to note that it contained 3.89 per cent of hydrogen over and above that required to combine with the 7.28 per cent of free oxygen present in the coal; while 14.56 per cent of the carbon was present in some form which yielded volatile hydrocarbons on heating. Although much has been written upon the subject of coal, the exact constitution and state of the various chemical elements before heating is still unknown; and it is an undecided point as to whether the oxygen and hydrogen and volatile portions of the carbon, are present in coal in the free or combined state.

Approximate analyses of other bituminous fuels, with their calculated calorific values in pound-centigrade units, are given below:

No.	Ash.	Volatile Matter.	Coke.	Calculated Calorific Value.
	Per Cent.	Per Cent.	Per Cent.	
1....	12.45	27.90	72.10	7,565
2....	13.80	31.00	69.00	7,347
3....	6.20	33.30	66.70	8,041
4....	7.75	34.00	66.00	7,764
5....	6.50	36.50	63.50	7,703

All the above tests were made on samples dried at 230 degrees Fahrenheit, and the low percentages of ash contained in samples Nos 3, 4 and 5 were due to these being washed slacks of exceptional cleanliness. When the percentage of volatile matter, yielded by a fuel on heating, rises above thirty-five per cent, the fuel is exceedingly difficult to burn without smoke production. The percentage of volatile matter given off by a fuel, is in reality a measure of the difficulty of burning it under the boilers, with perfect combustion of its component parts. Bituminous coals containing over thirty-six per cent of volatile matter are known as "cannel" coals, and are used chiefly for gas-making purposes. All bituminous fuels require careful management and large brick-lined combustion chambers, if they are to be burned without smoke.

The length of flame produced by bituminous coals depends upon the percentage of volatile matter, and this in its turn depends upon the amount of hydrogen they contain, over and above that required to form water with the oxygen present in the coal.

This surplus hydrogen combines with the carbon to form Methane (CH_4) Ethylene (C_2H_4) and Acetylene (C_2H_2), three hydro-carbon gases which yield carbon dioxide and aqueous vapor when burned under perfect conditions of combustion. When the air supply or the temperature is insufficient, partial oxidation only occurs, and portion of the carbon of these gases separates in the form of soot. The percentage of surplus hydrogen, is, therefore, another measure of the difficulty of burning bituminous fuel. This difficulty increases with the ease and rapidity with which these hydro-carbon gases are evolved by the fuel, on heating.

Nearly all bituminous fuels contain sulphur in the form of iron sulphide (FeS_2) as an impurity. The percentage of iron sulphide or "brasses," varies greatly in different classes of this fuel. On heating, half of the sulphur is liberated and burns with evolution of heat to form sulphurous acid gas (SO_2), which sooner or later condenses in the form of sulphuric acid (H_2SO_4). It is this compound and not the carbon or soot, which produces the larger part of this destruction of vegetation and of buildings in the neighborhood of industrial districts and of large cities. Recent calculations[1] have been made to show that in London over 500,000 tons of sulphuric acid are produced annually by the sulphur impurity contained in the coal burned in the metropolitan area. A similar calculation for the coal burned annually in the whole of the United Kingdom gives 5,000,000 to 7,500,000 tons of acid. The use of lime has been advised for fixation of this sulphur in the form of calcium sulphate in the ash of the fuel, but a far more certain and safer method would be to pass the products of combustion through scrubbing towers filled with flints. The sulphur contained in the exit gas could then be recovered in the form of a valuable by-product, namely, hyposulphite of lime or soda. As already stated it is the sulphur and not the more visible soot and smoke which is the chief cause of the damage effected by smoke. The carbon blackens, but the sulphur corrodes metal, destroys brick and stone and kills vegetation. Any practical method which would remove the sulphur from coal, or its products from the waste gases, deserves, therefore, most careful consideration by steam-users. Until such method has been generally adopted the sulphur contents of coal ought always to be kept as low as possible by careful picking of the fuel and removal of the veins of pyrites or "coal brasses." In large purchases of fuel by contract a clause ought to be added with respect to the amount of this impurity—and no coal should be accepted containing over one per cent of sulphur.

(Chapter I to be concluded.)

[1] Dr. Rideal, at London Smoke Abatement Conference, December, 1905.

The Sao Paulo Tramway, Light and Power Company.

By F. M. Felker, Electrical Engineer, General Electric Company.

THE Sao Paulo Tramway, Light and Power Company was formed under the laws of the Province of Ontario, Canada, for handling a concession covering electric lighting, power distribution and street railway operation in the city of Sao Paulo, the capital of the state of that name in southern Brazil. The installation of this company is representative of the difficulties of engineering work prosecuted under the peculiar local conditions existing on the southern continent.

At the time of the development a careful consideration of the local conditions was made, and inasmuch as fuel was very high, a thorough examination of the possibilities of water power was conducted. This examination extended over a period of two months, during the season of least rain, and as a result the locally famous Cachoeira do Inferno (Rapids of Hell) were decided upon as offering the desired conditions for power development. As the distance was only twenty-three miles from Sao Paulo, and no other available power existed within transmission limits, the location was favorable not only from an engineering but from a commercial standpoint.

The city of Sao Paulo is well built and well arranged, and is located upon a plateau 2,500 feet above the sea and about forty-five miles from its seaport, Santos, Brazil. It has a population of about 275,000, and is steadily growing. The business of the city is dependent upon the shipments of coffee, and it acts as a sort of clearing-house and supply depot for the annual export of 10,000,000 bags, holding 132 pounds each. The tributary country of Sao Paulo produces sugar, cotton and other products of the soil in abundance, while cotton, flour and woolen mills, with factories for the manufacture of hats, shoes, bricks, coffee and sugar bags are plentiful.

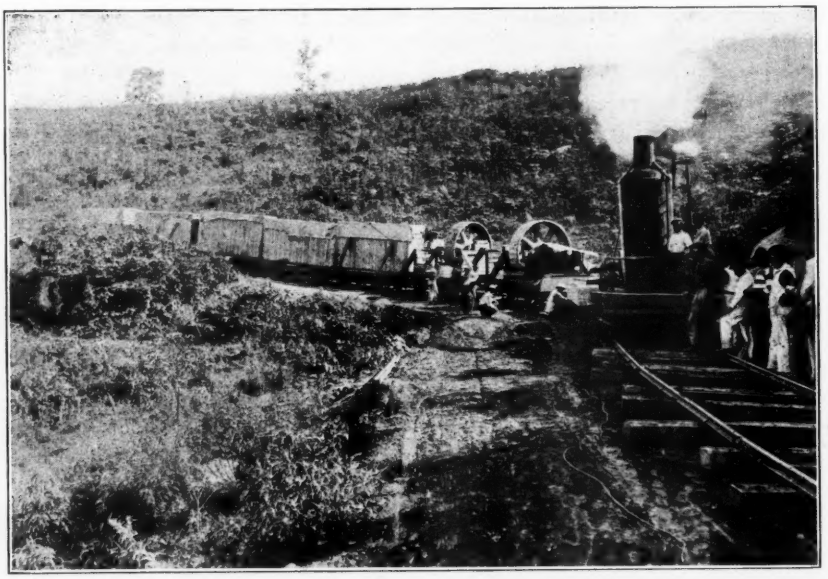
In a general way, then, the foregoing were basic conditions upon which was founded an investment of $6,000,000, which covered complete street railway and lighting and power systems, together with a water-power and distribution plant.

The "Rapids of Hell" previously mentioned are situated where the river Tiete flows through the village of Parnahyba, twenty-three miles from Sao Paulo. This river drains a watershed of 2,700 square miles, having an annual precipitation, as shown by well-kept government records, of an average of fifty-nine inches of rain on forty-five per cent of its area, and 130 inches on its remaining fifty-five per cent. Periods of drought are unknown, and the months of minimum rain show two inches of precipitation. Inasmuch as the entire basin is overlaid with heavy vegetation, the supply of water is excellent. The gauging of the stream, verified by actual measurements over the finished weir of the dam, shows that, allowing a shrinkage of forty per cent in the estimated lowest possible water, there will still remain a sufficient quantity of water to generate 20,000 horse-power for each twelve hours during the period of least water.

In developing this water power two dams were constructed, known respectively as Dam No. 1 and Dam No. 2. Dam No. 1 is located across the head of the rapids, and creates a pond up river approximately eight miles long, and having a width averaging 1,000 feet. The water is conducted down stream for a distance of 2,300 feet through the main pipeline, twelve feet in diameter, to the secondary reservoir above dam No. 2. From dam No. 2 the water is conveyed to the power-house through a set of four steel pipes, each eight feet in diameter for the generators, and thirty-inch pipes for exciters. Dam No. 1 raises the original level of the water thirty-nine feet. The fall in the river from below dam No. 1 to the tail-race at the power-house is 38.4 feet, making a total static head of 77.4 feet, or a working head of seventy-five feet on the turbines.

The main dam (No. 1) is 860 feet long, with a spillway of 462 feet. In building this dam the river was shifted twice in seventy-eight days; 2,000 feet of coffer dams were built to hold back a head varying from three to eighteen feet, and 9,000 cubic yards of masonry were put in place during this time.

Foundations for the dam were all solid granite ledge, proved by exploration drills, Foundations were trenched to receive the dam, which varied in height above the foundations from forty to seventy-three feet, with a width on the base line of thirty-six feet. The exposed faces of the dam are granite Ashlar, cut to one-inch joints. The interior is filled with heavy granite backing set in concrete.



THE SAO PAULO TRAMWAY, LIGHT AND POWER COMPANY—MOVING HEAVY ELECTRICAL MACHINERY BY STEAM POWER AND PORTABLE TRACK.

The main pipe-line starts at dam No. 1, at a point twenty-four feet below the level of the crest of the dam. The pipe is twelve feet in diameter, is of three-eighths-inch boiler steel, and is 2,300 feet long. It is supported every twelve feet in its length by steel saddles, resting on stone pedestals. The pipe is straight in alignment, and is provided with three expansion joints which divide the pipe into four sections of 575 feet each.

The water from the pipe-line is discharged into an open reservoir, the reservoir being made by building dam No. 2 across a ravine. The object of this reser-

voir is to form a cushion for the elimination of impacts in the main pipe-line, due to changes in velocity, and also to provide a quick water column for the secondary feeders to the turbines proper. The use of this method of eliminating the disasters commonly found in attempts to obtain first-class regulation where long pipe-lines are in use is believed by the designing engineer to be original. Original or otherwise, the results have been most satisfactory, and turbines operating 2,500 feet away from the impounding dam are being regulated with a variation of one and one-half per cent from normal, upon a circuit carrying only a street railway load, and subject to excessive variations in current, owing to heavy and frequently occurring grades in the track.

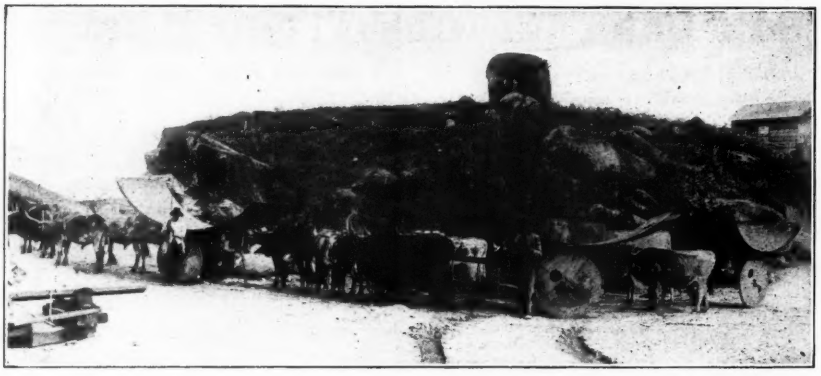
The power-house is a fireproof building of steel, brick and concrete construction. Dividing walls are built of concrete with concrete floors, and the building has a tile roof. The complete electrical apparatus was furnished by the General Electric Company, and consists of four 1,000-kilowatt, sixty-cycle generators and one 2,000-kilowatt generator; twelve 333-kilowatt air-blast transformers, arranged in four banks of three each, stepping up from 2,300 to 25,000 volts and three 666-kilowatt transformers; three blowers and two 100-kilowatt exciters, with switchboard for the control of this apparatus. The switchboard is arranged with duplicate bus-bar system for both high and low tension, and is so arranged that any one of four transmission lines can be thrown in or out of service, with division of load for lighting and railway work. The water-wheels are controlled by Lombard governors, and the general operating conditions have proven very satisfactory. The main station equipment has recently been increased by a sixth generator of 2,000 kilowatts capacity built by the General Electric Company. Additional transformer capacity has also been necessary, all the new apparatus including the switchboard panels being of the same American manufacture.

The power is transmitted twenty-three miles to Sao Paulo over the company's own right-of-way. Duplicate pole-lines have been erected, the two lines being separated about thirty feet. On each pole are two sets of three-phase transmission lines, consisting of three No. 0 copper wires. The right-of-way is cleared to about thirty feet each side of the pole-line.

At the substations the equipment includes twelve 22,000/2,200-volt, 333-kilowatt step-down transformers; two 500-kilowatt railway generators, driven by 700-horse-power induction motors, and two 500-kilowatt railway generators driven by 700-horse-power synchronous motors. There is also a booster, compressed-air outfit and large feeder switchboard, as well as the main controlling boards for the apparatus outlined above.

THE SAO PAULO TRAMWAY, LIGHT AND POWER COMPANY—INTERIOR OF POWER-HOUSE, PARNAHYBA, BRAZIL.

The transportation problems in connection with the hydraulic development were quite serious at the start. It was necessary to build an entirely new road from the railroad to the power-house site, and the first examples of transportation by local methods were very discouraging. The only vehicles were carts hauled by oxen, with solid wooden wheels, rigidly fastened to the axle, the axle turning in wooden bear-

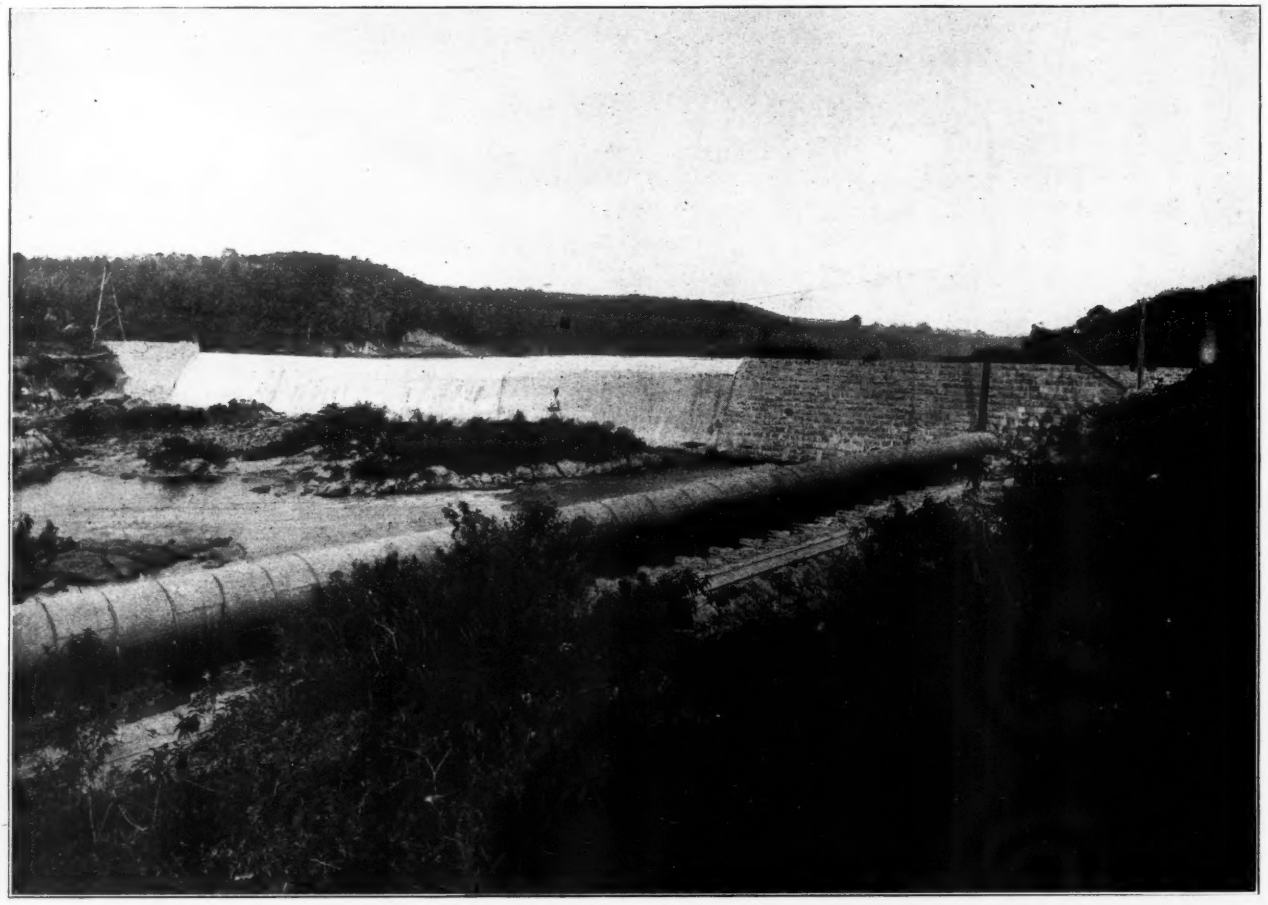


THE SAO PAULO TRAMWAY, LIGHT AND POWER COMPANY—HAULING PIPE SECTIONS BY OX-TEAMS.

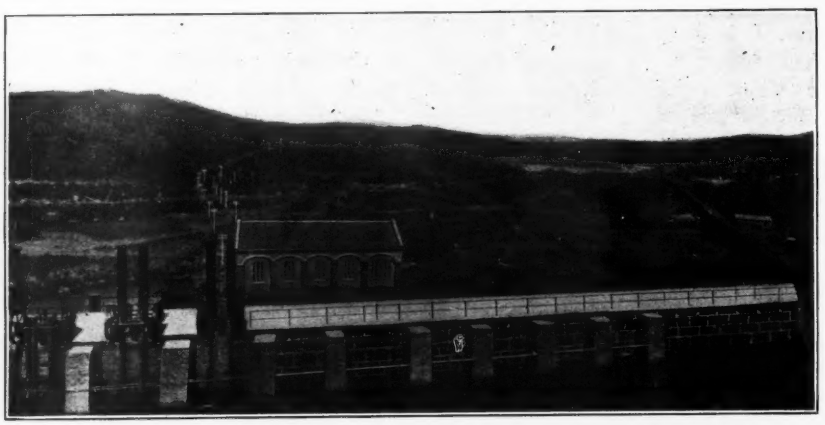
ings. The natives naively claimed that the oxen would not pull these carts if they were greased, as the noise made by the axle turning was absolutely necessary to urge the animals to their task. They stated also that the friction was an advantage, as it acted as a brake going down-hill, but said nothing about going up-hill.

In regard to the load that the oxen were capable of pulling, for example, it required ten oxen to haul one pole (weighing 1,500 pounds), and the first mules which were employed took four to six barrels of cement on two-wheel carts.

Steps were immediately taken to import some American wagons, and a lot of wild mules were purchased and broken on the ground. After two months of modern methods, they were able to haul with six mules twenty-four barrels of cement, making the trip in one-half the time that was required previously with the natives.



THE SAO PAULO TRAMWAY, LIGHT AND POWER COMPANY—MAIN DAM, LOOKING UP STREAM.



THE SAO PAULO TRAMWAY, LIGHT AND POWER COMPANY—PANORAMIC VIEW OF POWER INSTALLATION, SHOWING TRANSMISSION LINES.

The transformers weighed five tons each, and in order to draw these over the local roads it was necessary to use a truck with twelve-inch tires, and special frame or cradle to carry the transformers, swinging on steel cables, so that they could not tip over. Fourteen mules were required for each wagon, and one round trip was made in one and one-half days. It was

found that five tons was the limit of load with wagons, and some other scheme had to be devised for hauling the remainder of the electrical machinery, which was in pieces weighting ten tons or more. An attempt was made with the first piece, weighing ten tons, to haul it over in a wagon, and the trip took three weeks, because for the entire distance it was necessary to pull the wagon along with heavy block and tackle, and slow-moving animal power.

For transportation of the heavy material, a number of small cars were made, and a 1,500-foot section of track was arranged to be laid without spikes. One of these cars carried a small hoisting engine, which was run ahead to the end of the 1,500 feet of track, and the cars loaded with machinery were drawn up to the engine. While the machinery was being pulled ahead, men and teams tore up the track back of the cars and carried it ahead, laying it as rapidly as possible, so that as soon as the last car had been pulled up to the engine the track ahead was again ready for operation. By this means seventy-five tons were hauled seven miles in twenty-eight days, while it required three weeks to haul ten tons the same distance by wagon.

Many difficulties similar to the foregoing are of course always incident to the establishment of modern machinery in the newer countries, and other difficulties were met with in the work even in this more advanced community. It was found impracticable, for instance, to let contracts for the work owing to the absence of reliable contractors. Accordingly, the entire plant was built by "day-work," and the construction plant, and organization therefor, were shipped from North America. This included seven good American foremen, twelve derricks, three pumps, one aerial cable-way, one rock crusher, eight steam engines, one air-compressor plant, five boilers, and all necessary small tools for the work.

Work on this development was commenced in September, 1899, and the plant was completed and in operation during the same month, two years later. From the beginning there has been a healthy growth in the adaptation of electric power, and at the present time the company operates seventy-three electric cars over about seventy-five miles of track in Sao Paulo and its suburbs. Power is also supplied over the same territory to about 36,500 lights, and nearly 5,000 horse-power is used in various manufacturing enterprises.

The head office of the company is located at Toronto, Canada, the officers being: Wm. Mackensie, president; Frederic Nichols, vice-president, and J. M. Smith, secretary-treasurer. The complete electrical equipment was furnished and installed by the General Electric Company.

The Telephone Situation in Chicago.

By a Staff Correspondent.

WITHIN the past few years there have been developed in the city of Chicago conditions respecting the telephone service rendered by the Chicago Telephone Company which are both complicated and unusual, and in order to understand them it is necessary to go back to the early history of the company and its development.

During a number of years previous to 1889 two companies had operated exchanges in the city, and the large majority of users found it necessary to pay for the service of both. The properties were finally united, and in 1889 an ordinance was passed granting the Chicago Telephone Company for twenty years the right to operate in the city, which then embraced an area of thirty-seven square miles, the company undertaking to pay to the city, three per cent of its gross receipts from its telephone business done within the city for the privileges afforded. It also agreed not to increase its "rates for telephone service now established" beyond $125 for unlimited service on a business line within a territory known as the "Blue Line" and embracing an area a little less than half of the city limits as they then existed. Beyond this line, $25 per year per mile was to be charged. As this was before the introduction of long distance lines and metallic circuit service in Chicago, the rate referred only to the grounded single-wire service which was then in use. Outside of the Chicago city limits the company operated under franchises obtained from various towns and villages which adjoined Chicago, such as the village of Hyde Park; the town of Lake, etc., and under these various franchises the telephone service was developed.

Late in 1892 the long-distance wires from New York were constructed through to Chicago, and it was found that service rendered over them by means of the grounded exchange lines of the Chicago company was not satisfactory. To make this long-distance service available it was necessary to construct special metallic circuits and install long-distance instruments. This was done for long-distance service and no other at a rate of $96 per annum. Many subscribers had both telephones; one for local service at $125 and one for long-distance service at $96. Later on, these and other subscribers desired to combine the two services in one set of instruments. Special switchboards were installed by the company to make this possible, and about July, 1893, a rate of $175 per annum was made for the combined service. The company at the same time continued to furnish the grounded line exchange telephone service at the $125 rate.

Meantime the city of Chicago had annexed a number of the surrounding towns and villages and had increased in area from 37 to 191 square miles. The company at the same time extended its exchange boundaries at the $175 rate beyond the old "Blue Line" and gradually took in a considerable portion of the territory which had been annexed, greatly reducing its mileage charges.

The work of developing the service continued, and improvements in the way of operating exchange lines and switchboards were introduced as rapidly as they became available. Indeed, a considerable number of the improvements which have since become standard and which are now used throughout the world were first put into use in Chicago. Among them may be mentioned the incandescent electric light used as a telephone signal. This and many of the devices which have made it so valuable were the inventions of employés of the Chicago Telephone Company. Methods for operating party lines were also developed and successfully introduced, and service to residences was rendered by means of it at rates which were little more than half those the company had the right to charge. When measured rates were introduced in New York and elsewhere this plan of charging was introduced by the Chicago company, and by means of it large numbers of telephone users secured all the service required at a reduced cost. Still later, the prepayment or nickle-in-the-slot plan was introduced in which the service is paid for at the time rendered. This plan, originally introduced in San Francisco, was carefully studied by officials of the Chicago company and after a trial in one

of the exchange districts was extended throughout the entire city. An initial guarantee of the minimum amount which should be paid to the company was made by subscribers to the nickel service who paid at the rate of five cents for an exchange call. If the receipts were less than the amount per day which had been guaranteed, the subscriber undertook to make up the difference. Rates were made with guarantees as low as five cents per day for ten party-line telephones in residences. These were operated at special switchboards under special designations and numbers and in no way interfered with the general exchange service of other subscribers.

The prepayment or nickel service was immediately popular and developed more rapidly than any other, so that the growth of the exchange continued to be rapid, requiring the erection of fireproof buildings to accommodate the sixteen exchange offices now in operation, and the installation of relay multiple switchboards of the best and most modern type.

After the introduction of the metallic circuit service, the question as to the company's right to charge $175 per annum was taken up by the city council, and the corporation counsel advised that as long as the company continued to provide the $125 service it had a right to charge a higher price for a different and a better service. The same question was brought up at another and later date, and a second corporation counsel ruled in the same manner.

The company therefore continued to give the $175 service as well as the $125 service and a large number of other classes at rates lower than $125 and believed that it had a right to do so. The question was finally taken into the courts, where a different ruling obtained in 1902, and the company was enjoined from charging more than $125 for its exchange service within the ordinance "Blue Line" and the mileage as named in the ordinance for points beyond it.

This suit against the company had been started in behalf of a small number of plaintiffs. A corporation known as the Chicago Telephone Adjustment Company was immediately organized by outsiders and set about to canvass among subscribers of the Telephone company to take their claims against it for amounts which they had paid the company in excess of $125. This Adjustment company engaged the same counsel as represented the former case, then under way, and these clients were included in the suit as rapidly as their interests had been secured by the canvassers of the Adjustment company, which company was to receive one-third of all sums collected. These clients under the injunction paid but $125, and bond was given for the balance. The Telephone company then, in response to enquiries from other subscribers, arranged that they might pay at the rate of $125 and give a bond to pay the balance if the $175 rate was finally upheld. To a number of other subscribers who continued to pay $175, the company agreed in a letter to repay the excess amount if the rate did not hold good. The Adjustment company continued an active canvass in its endeavor to secure the claims of as many subscribers as possible.

Suits also were brought against the company by subscribers who at one time had paid at the rate of $175 but who had not continued to be subscribers. This suit was tried out and all of the points involved in the controversy were taken up in it. It had been claimed that the subscribers were obliged to pay $175 and had paid this rate under duress. It was proved that the contrary was the case and that subscribers, had they so chosen, might have continued the $125 service and that there was no force or duress on the part of the company and that they were not forced to take the combined local and long-distance service or pay the $175 rate. This suit was decided in favor of the company, it being stated that as the subscriber had voluntarily entered into the contract and at the time of taking it had not objected to it or taken it into court, he had no claim for repayment, but must abide by the terms of the contract which he had executed.

In 1905 the city of Chicago, through its corporation counsel, who did not agree with the former corporation counsels, began another suit against the company: first, to oblige it to charge only the $125 1889 ordinance rate for its exchange service, and second, to oblige the company to pay three per cent of its gross receipts from its telephone business throughout the entire present city limits of Chicago, and, although it was shown that the $125 service had always been continued by the company and was used by several thousand subscribers at the time the suit was brought, and, although it was shown that the company with the concurrence of the city had continued to furnish service and operate in the annexed territory under its various ordinances, in the village of Hyde Park; the town of Lake; the town of Jefferson, etc., the Supreme Court of Illinois decided in favor of the city on both counts. The final trial and decision has not yet been had, but the company has paid to the city on account, without prejudice, the amount of the compensation claimed and has proceeded to charge for the combined exchange and long-distance service facilities at the rate of $125 instead of $175, which had been the rate since 1893. The Court's decision astonished lawyers, for it substituted the Court's opinion as to the meaning of the ordinance in place of the meaning openly acted upon for over ten years by the city and the company between whom the ordinance is a contract.

The suit in behalf of clients of the Adjustment company and others who sought to have the company repay all amounts received in excess of $125 was still continued.

Outside of the complainants in this suit, certain subscribers had paid at the $125 rate and given bond for any excess. Some others had received the letter from the company agreeing that it would pay back if the higher rate did not prevail, and a large number, indeed the majority of all users of this class, had continued to pay at the $175 rate.

It was finally decided by the company that it would pay back in full to all subscribers any amounts received from them in excess of $125, back to the date on which it had first been enjoined from charging at a higher rate. This was in January, 1902, and subscribers are now being paid in accordance with this arrangement as rapidly as their claims are received.

Meantime, as the exchange continued to grow at an ever-increasing rate, and the number of telephones increased so rapidly as to require the expenditures of greater sums each year for plant, it was considered advisable to take up with the city the matter of an extension of the company's ordinance granted it in 1889 and which expired in January, 1909, and negotiations were entered into with the committee of the common council and are still under way.

In these the company has submitted the fullest explanation of its affairs and invited the closest scrutiny into its rates and methods. It has been shown that the stock of the company has not been "watered" but for every dollar of stock a like amount has been invested in its plant, which has been well built and maintained and represents the best developments in telephone engineering and operation. It has been found that about ninety per cent of all subscribers are paying for service upon some one of the many forms of meas-

ured rates now offered and that out of more than 116,000 telephones only about 8,000 are the so-called flat-rate-business telephones. It has been shown that a very much lower rate of measured rates, particularly for the small users, can be offered if subscribers of all classes pay for the amount of service rendered to them and that a continuance of a flat rate for a few will necessarily require the maintenance of a higher measured rate for the many. The company's proposal, therefore, has been to charge for its exchange service at measured rates. This would bring about not only a great improvement in the service, doing away with the ten-party lines which have tremendously increased because of their low cost and changing the service of these to four-party lines for residences and two-party lines for business places, but it also would lead to a very great growth in the exchange which would increase the value of the service to all subscribers. The proposal also has been to include the entire city limits in the exchange area, thus including within one zone and upon one basis of rates a larger area than any exchange in the world and at lower rates. The proposal has been also to continue the operation of neighborhood exchanges in outlying portions of the city where very low flat rates are charged for the comparatively small number of telephones required by these various communities, and to charge a toll rate of five cents from these neighborhood exchanges to any other telephones within the city limits outside of their own districts.

In the course of negotiations public hearings were called at which many patrons of the company appeared, and the general evidence was overwhelmingly to the effect that a good service was being rendered by the company; that lower rates and extended service would be desirable and that a comprehensive service rendered at fair rates by one company would be best for the community.

At other hearings, representations were made in behalf of the Manufacturers' Association, one of the associations of manufacturers and business men of the city, that this association proposed to go into the telephone business and ask for a franchise. A considerable number of the members of this association protested against the use of its name in this connection, and the proposal was later modified to the statement that some members of the Manufacturers' Association intended to form a company and apply for a franchise.

Another company proposed to operate telephones at a lower scale of rates than had been proposed by any other and then in five years to give the entire plant to the city without any recourse. At one meeting of the committee no less than five separate propositions of various kinds were made by people desiring telephone franchises. The general expression of telephone users, however, has continued to be that one comprehensive service at low rates, fitted to all classes of users, was much to be desired, and that the extensive operation of two or more companies would greatly add to the public's expense and to the confusion of the service. The situation to-day is, therefore, that the company is paying to all subscribers upon request any sums which they have paid in excess of the ordinance rate back to January, 1902, and continues to defend the suits against it by subscribers who do not wish to settle on that basis, and it is proceeding in its negotiations with the city council in the matter of an extension of its ordinance.

Some $16,000,000 have been expended by the company in its plant and the extension of business in Chicago and surrounding counties. About one-half of this has been paid by Chicago stockholders. A majority of the directors of the company are Chicago men who have been and are identified with the best interests of the city. They have authorized the extension of the service to meet, as satisfactorily as possible, the requirements of the public. Extension of exchange boundaries and reductions in rates have been made from time to time as the development of the various classes of service has warranted.

Without waiting for further action in the matter of its application for an extension of the ordinance, the company has just made a substantial reduction in exchange rates, affecting measured rates, private branch exchanges, extension telephones, ten-party lines and others, and in connection with its ordinance extension has offered very many more reductions which will affect not less than ninety per cent of all telephone users in the city.

The management of the company has believed in Chicago and believes that its endeavors to provide a first-class telephone system and service will meet with the fair and just consideration of the city's council and its executive officers. At the very low rates proposed by the company, Chicago should be not the second but should again lead all cities in the world in the number of telephones. It is evident that the best interests of the greatest number of people will be served by meeting the Chicago telephone situation with a square deal.

The Liberal Education.[1]

If it be held that one must needs have the so-called liberal education in order to be well rounded, it is pertinent first to determine whether roundness is what is really wanted and the fitness of the subject to the end. We don't build walls of round stones. We hew them square—some are better rough hewn and others are better when polished. It is not well to attempt to take all the corners off humanity. They should be left on to dent something.

When it is observed that in our modern universities which offer to students wide ranges of educational courses, less than one-quarter follow classical pursuits when left to free choice and that over three-quarters elect professional and industrial education, there is good reason to believe that this is about the proportion in which minds are fitted to receive benefit from the acquirement of the respective classes of knowledge and training. I therefore maintain that instead of decadence in the humanities they are elevated by this natural selection because their representatives become only those whose minds are fitted to take such education and who will therefore conspicuously represent the best possibilities of classical training applied to those to whom it is adapted.

In addition to the several agreeable and desirable attributes of classical training, its fundamental benefit comes through the melting down and recasting of thought, which to some minds is a stimulating and cultivating process. There are other processes of like kind and quality that are adapted to other minds, notably the melting down of the laws of nature and recasting them as applied science. Another cultivating and most useful process, too little practised, is the melting down of one's own thoughts and so recasting them that they can be understood.

We have heard too much about knowledge for its own sake *versus* knowledge for use. All knowledge is for use. All education is for action. The engineer uses mechanics and thermodynamics in a certain direct way. The architect uses art and constructive knowledge in a similar way. The lawyer uses his knowledge in a less material way. The classical or philosophical man uses his acquirements in a different way, but if he does not use them they are useless. The older I grow the more I think there is no such thing as liberal education, liberal arts, or liberal anything, as distinct from specialized departments of knowledge. As to the so-called specialized courses, these are only names. They are no more special than the humanities. Some are scarcely so highly specialized. All education is liberal or all is technical, according to our definitions, but all is for use.

[1] Excerpt from an address delivered by Walter C. Kerr before the graduating class of Staten Island Academy.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

Apparatus for Automatically Connecting in Parallel Polyphase Machinery.

An apparatus for automatically throwing in parallel polyphase alternating-current machinery is described here by Dr. Gustav Benischke. The author discusses first the conditions which must obtain in order to carry out this operation successfully and shows how advantage may be taken of the conditions existing at the moment of synchronism of the two or more machines to be coupled together. The device consists of three parts—a synchronizer or apparatus which comes into action at the moment of synchronism; a time relay operated by the former, but which closes an auxiliary circuit only when the conditions of synchronism last for a certain definite period; and an electromagnetic switch operated, in turn, by the time relay, which is actuated whenever the latter is closed and which connects the machines together. The synchronizing apparatus is an electromagnetic device actuated by two or three windings, depending upon whether the system is a two or three-phase one. When these windings act together a switch is closed, bringing into play the time relay. If the period of closure lasts long enough, the time relay closes the circuit of the electromagnetic switch and thus throws the machines in parallel. The device employed for this is illustrated and described, and the theoretical conditions are considered somewhat in detail. It is pointed out that these devices may be combined. For example, the synchronizing apparatus and the time relay may be made as one instrument.—*Translated and abstracted from Elektrotechnik und Maschinenbau (Vienna), July 22.*

Regenerative Control and the Bow Collector.

Certain unfortunate accidents occurring on British trolley lines have led G. Hooghwinkel to call attention to certain protective features which he thinks are inherent in the so-called regenerative system of control and in the bow or sliding bar collector. The regenerative control system makes automatic and sure braking possible, and since it is employed with shunt motors, constant and fixed speeds for every position of the controller are obtained. As early as 1896 the author used these motors is the town of Essen, Germany, but, as copper brushes were employed, sparking occurred, causing the throwing out of the system. This trouble may be avoided by employing auxiliary poles and carbon brushes. Experience with such systems of control in rolling mills, where the service is equally severe, indicates that it would be entirely successful if applied to railway work. With respect to the bow collector, the advantages claimed are the impossibility of its flying off the wire, the little attention required, and the possibility of reducing the number of switches and pull-off wires on curves. This collector has been employed by the Sheerness electric tramways, where it has been most successful. Some trouble was encountered at first due to the breaking of the cast-iron standards which had, by mistake, been substituted for steel. Replacing these with steel did away with the trouble. During the whole of the time these tramways have been in operation (over three years) no repairs have been necessary to the overhead equipment, beyond renewals of section insulators and about half a dozen span wires. The trolley wires are still in very good condition. The bow is of aluminum and runs about 5,000 miles. It costs about $1.60 to renew it, neglecting the value of the scrap, which is about sixty cents. It weighs about eight pounds. The author suggests that the substitution of this collector for the trolley, which does away with a good deal of the ugly overhead equipment at switches and curves, may prolong the use of the overhead system in cities. He is convinced that the trolley wire will last longer when this collector is used than when the wheel is employed.—*Abstracted from the Tramway and Railway World (London), August 9.*

Charging Storage Batteries when Employed as a Reservoir of Energy.

The advantages of storage batteries employed as a reservoir of energy are discussed here by M. F. Loppé, and the conditions which must be met for successful charging and discharging without excessive loss of energy. The main trouble is due to the wide variation in voltage of the batteries according to the condition of the charge. In order that the voltage of the batteries may be equal to that of the system during discharge, it is necessary that the voltage at which they are charged be considerably greater. To accomplish this either a booster may be employed, or the battery may be cut into sections, which are charged independently or in parallel. Several possibilities are open here. The battery may be cut into two equal sections connected in parallel and charged in series with a rheostat, in which case the loss is considerable. Or it may be cut into three sections, charged one section in series with the other two in parallel, or any other grouping desired. Or a third plan, now employed by Herr Micka, in Germany, who uses a peculiar arrangement, may be adopted. If the voltage to be delivered require N normal cells, he employs $\frac{2N}{3}$ cells having the necessary capacity and $\frac{2N}{3}$ additional cells having one-half the capacity of the former. During charge each set of batteries is connected in series across the line, the current being regulated by rheostats. During discharge the smaller set of batteries is divided into two equal parts, which are connected in parallel in series with the larger set. In this way all batteries charge and discharge similarly.—*Translated and abstracted from L'Industrie Electrique (Paris), August 10.*

Electrical Cutting of Steel I-Beams and Girders.

The fire at San Francisco, Cal., following the earthquake of April 18, has left some difficult problems to be solved in the clearing away of débris for new buildings. One of the most serious of these is the removing of the tangled mass of structural steel. It occurred to R. E. Frickey that the electric arc might be employed here to advantage, and he has carried out at the University of California some experiments to determine the possibilities of this use of the arc. As a result of extensive experiments an electrode has been evolved which has proved successful. By means of this electrode a fifteen-inch I-beam was cut in two in twenty minutes. To make a corresponding cut with a hack

saw would require several hours. For the best and most economical results a current of about 250 amperes at from 90 to 100 volts is required, although a lower voltage would be more economical. Since the counter-electromotive force of the arc is about forty volts, any potential but slightly greater than that would not give a current sufficiently constant, as slight variations in the length of the arc would produce very serious changes in the current value. A considerable resistance is employed when the higher voltage is used, which maintains the current constant and does away with the difficulty of starting. A further advantage is that the higher voltage gives an arc less likely to be blown out by wind, as it is not so sensitive to external conditions. Since the positive side of the arc is the hotter, the electrode is always negative. In starting, a resistance is employed, but this may be cut out after the arc is formed. One necessary condition for success is the satisfactory protection of the operator. Not only the eyes, but the face and hands, must be covered, or they will be badly burned. An oilcloth hood having a rectangular opening in front of the eyes is employed, this opening being covered by a mask of oilcloth having a window of specially prepared glass when the arc is in operation. Gloves must be worn. Since it is not practical to obtain 110 volts for the work in San Francisco, and as it was not advisable to use the 220-volt system, since the neutral is grounded in that city, a portable generating set consisting of a gasolene engine driving a dynamo was arranged. This consists of a twenty-five-kilowatt, direct-current generator belted to a forty-horse-power single-cylinder gas engine mounted on a truck. The selection of the equipment was limited to a considerable extent by the apparatus available in the city. Although it can not be said to what extent this method will be employed in clearing the San Francisco ruins, it is believed by the author to be considerably cheaper than mechanical cutting.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), August 11.*

The Electrical Installations of the City of Schaffhouse.

The hydroelectric system described here by M. J. Reyval is particularly interesting, since it replaces one of the earliest attempts to transmit over some distance the power of a waterfall. As early as 1858 the city of Schaffhouse, Switzerland, realized the advantage to its industries which would be secured if the hydroelectric power of the Rhine at that point could be developed and distributed to the various shops. The plan was taken into consideration, carefully studied, and in 1860 the plan was put under the guidance of M. P. Reuleaux, and work was begun in 1863. The plant was completed and put into operation in 1866. A canal was dug so as to conduct the water of the river to a suitable point to utilize the fall. Three discharge gates were built and fitted with hydraulic turbines. These drove, through bevel gears, ropewheels, and the power was transmitted along the river banks and distributed to various points by means of ropes. The first plant consisted of three turbines, rated, respectively, at 200, 260 and 300 horse-power, making a total of over 700 horse-power to be disposed of. This old system continued in use until 1900, but in 1886 the demands for more power led to the adoption of a hydroelectric system. The old company then built a second power-house, somewhat lower down the river than the first, and equipped this for five 300-horse-power turbines. In 1890 two turbines were put into service, each driving a six-pole dynamo producing current at from 700 to 750 volts, and rated at 300 horse-power. The speed of rotation of the turbines was sixty revolutions per minute, and the dynamos were driven by means of bevel gears. In 1891 the three other turbines provided for were put into service, two of them being coupled to alternators generating single-phase current at 2,000 volts. The frequency employed was fifty cycles. The efficiency of these machines was ninety-two per cent at half load, and eighty-seven per cent at full load. In 1897 the company decided to suppress the old rope system, substituting for it a modern electric plant. The following year the company's plants were bought by the municipality and plans drawn to replace all the old machinery by new. The new stations were put into service in 1901. Single-phase generators rated at 350 horse-power, generating current at 2,000 volts, fifty cycles, were adopted. Modern switchboard and transformer equipment was installed, rotary converters put in place to supply the local railway, a storage battery connected in parallel with the system to balance the load, and the two plants made entirely modern throughout.—*Translated and abstracted from L'Éclairage Électrique (Paris), August 18.*

An Arrangement for Measuring Alternating-Current Frequencies.

Since the natural period of vibration of any electrical circuit depends upon its capacity and inductance, this fact may be utilized to determine such frequencies. By bringing into electrical or magnetic relation with the circuit, the frequency of the current of which is to be determined, another circuit whose constants may be varied, until resonance occurs, the known electrical conditions of the latter circuit enable the frequency of the former to be measured. Practically, however, the conditions are not so favorable, but they can be made fairly satisfactory, as is shown by Professor W. Peukert. The first trouble is due to the change in the value of the coefficient of self-induction of any coil with the frequency. This change may produce a considerable error, though for low frequencies it is usually negligible. Another difficulty is that the change in the self-induction of a coil depends upon the value of the self-induction itself. For example, the author shows that, for a certain spool having at a frequency of 145 cycles a coefficient of self-induction of 1.0003 henries, the coefficient rose to 1.0059 henries with a frequency of 870 cycles, an increase of one-half per cent. A coil having a coefficient of self-induction of 0.001 henry showed practically no change from low frequencies to a frequency of 2,000 cycles. With a coefficient ten times as great the change was 0.2 per cent, with the same change in frequency. With a coefficient of 0.1 henry the change was 0.55 per cent. When the frequency was increased to 10,000, the three coils mentioned showed changes in coefficients of one, two and 3.49 per cent, respectively. The same trouble is encountered in the condensers usually employed, but, fortunately, the error is in the opposite direction, so that one tends to compensate for the other. The author then describes several coils which he constructed in order to test his idea, and gives the results of his experiment. The frequency to be measured is that set up by the alternations produced by a singing arc. Measurement was made by suspending the test coil from a delicate balance and weighing it with a certain direct current passing through it. Then the circuit containing the coil was put in inductive relation with the arc circuit, and its constants changed until the effective value of the alternating current, as shown by the balance, was equal to the direct current, showing practically resonance. Knowing then the constants of the circuit, the frequency was computed. The results were found to be in fair agreement, although it was difficult to maintain the conditions at the arc constant, and for this reason the frequency there varied somewhat. The conclusion, however, reached is that the frequency of an alternating current may be measured by the arrangement described, and that this is particularly suitable for measuring high frequencies.—*Translated and abstracted from Elektrotechnische Zeitschrift (Berlin), August 16.*

Methods of Getting New Business

A DEPARTMENT DEVOTED to the COMMERCIAL DEVELOPMENT of CENTRAL STATIONS

Managers are Invited to Contribute Suggestions for Methods of Increasing the Demand for Electric Service

ORGANIZATION AND CONDUCT OF A NEW-BUSINESS DEPARTMENT SUITABLE FOR CENTRAL STATIONS IN CITIES OF 50,000 POPULATION AND UNDER.[1]

BY J. M. ROBB.

(Concluded.)

Give your newspaper talks direction. Select some person or prospect in your city, as nearly typical as possible of the prevailing type of people whose business you are going to get, and address all your talks to him. It has been demonstrated, in training street-car conductors to call streets and stopping-places, that announcements are much more easily understood if the conductor will direct his talk to some individual in the car, instead of just talking into space.

The same thing holds good in advertising.

You are going to persuade people to buy your service.

Very well! Point your arguments for some particular individual. Be direct; come to the point at once.

Use old-fashioned, plain English, the kind that says "Keep out" instead of "No admittance," or "Come in" instead of "Visitors are welcome."

Here are some suggestions:

"LET ELECTRICITY DO YOUR WORK."

"Get an electric iron. Then your ironing will be done with half the time and work. One will be sent to you on thirty days' trial if you 'phone to No.——."

"Get an electric warmer for baby's food. Then you won't have to chase down-stairs nights to the gas stove."

"Put up a porch light, with the street number on the globe; keep it lighted evenings. Let your friends know where you live when they call."

"How about the wear and tear that clothes-wringer takes out of your clothes? An electric centrifugal clothes-wringer will save it."

Change your copy every day. This is important, and it will lead many people to look up your advertisements to see what you will say next. The more people whom you can get to think about your business, the faster will it increase.

Keep a scrap-book file containing copies of every advertisement you run. If you will arrange your scrap-book in the order in which your advertisements appear, it will form an excellent means of checking your monthly newspaper bills.

Study every advertisement that comes to your notice in your endeavor to make your own advertisements different from the others with which it is printed. The effort will pay big returns.

DIRECT-BY-MAIL ADVERTISING.

A campaign of direct advertising by mail will still further increase your solicitors' efficiency. Mail will easily reach customers who will never see a solicitor, or get to them at times when a solicitor's call would be considered an intrusion and resented.

Be chary, however, of your use of circular letters, and do not place too much faith in the selling power of multicolored direct-by-mail stuff, artistically folded like a tablecloth or bedsheet.

Business men to-day are busy. A sentence in black type on a plain postal will make an indelible unconscious impression, where a choice collection of pictures on a square yard of wrapping paper will only produce an emphatic cuss-word and a vigorous shove toward the waste-basket.

The chief value of a circular letter is its personal appeal. Therefore is the necessity for its preparation with consumate care, to give it all the effect of a personal appeal to the reader.

If you do send out circular letters, enclose with each one an addressed postal (not a mailing card without a stamp) so that, when your letter makes the desired impression, the postal will be mailed before your prospect changes his mind in hunting for a one-cent stamp.

Be sure, too, that the postals are numbered for identification, for sometimes prospects mail cards, forgetting to sign them.

If you have an addressing machine, have the addresses of your respective customers set up for it, and arrange to keep it up to date. This will put you in position to effectively and quickly reach your prospects with any proposition you want to push.

Number consecutively the printed matter, mailing cards, circular letters, etc., that you send out; keep a scrap-book with copies of all such matter and have the date and number stamped upon your possible-business index sheets. By tabulating the orders secured from each lot of matter mailed out, as shown by the entries on the possible-business index, you are in position to judge the effectiveness of what you are distributing.

COOPERATION WITH EMPLOYES.

Do not end your work among your own men with training your solicitors. Work up the interest of every man connected with the company. Make them all see the possibilities that can be obtained if every man makes use of the opportunities for boosting the company's business that come to him every day.

Organize a progress club among the men, with meetings to be held monthly, or oftener, at which matters relating to the service, the sales of appliances, their use, the betterment of the service, etc., can be discussed. Invite their criticism and study their suggestions. This work will cost much in time and energy, but better results will be secured than can be obtained in any other manner.

SALESROOM.

Your salesroom is a most important adjunct of your new-business department.

First impressions count for everything with some people and for something with everybody. Your condition will govern the quantity of apparatus you can display, but even if you show only a flat-iron, you can show it, if you will, so that it will attract interested attention.

Don't neglect to have a glass-case watt-meter connected up so that you can demonstrate its operation any time.

Make use of the pamphlets, etc., that manufacturers of electrical apparatus will supply you for the asking. Everything helps.

CATALOGUES.

Keep carefully filed, for reference, every catalogue of current-using apparatus you can obtain. Study your catalogues and have your solicitors study them. They will suggest endless applications demanding the use of current, many of which can be profitably used by your consumers.

APPLIANCE POLICY.

Make your selling prices for appliances bring you the same rate of profit a dealer

[1] Winner of the third prize offered by the Cooperative Electric Development Association.

would expect, but scrupulously put into advertising or soliciting every cent of such profit. This practice will encourage dealers to handle electrical appliances. Cooperation is what you need, and the more people in your territory who can be induced to push electrical appliances, the better will it be for you. The practice of selling appliances at cost, or less than cost, further has the tendency to confirm the popular opinion of the profits from the sale of the current. Then, too, many people measure the value of an article by its price, and emphasizing the low price of what you are selling depreciates it to them.

Selling electrical appliances is more a matter of salesmanship than price.

Convince your customers of the value of your service. Create in them the desire to use it. It can be done by persistent work. Make your terms easy; small payments on long time, and they will buy.

Offer every appliance you handle on trial long enough to thoroughly demonstrate its convenience and utility.

Follow up every appliance sold, with a careful inspection, to ascertain that it has been properly set and that its operation is thoroughly understood.

COOPERATION WITH CONTRACTORS.

Display in a prominent place in your office a wall directory of all the electric contractors in your territory. Arrange to send them immediately any tips coming to your notice concerning wiring work, etc.

Keep in touch with your contractors, establish friendly relations with them and consider their criticisms and suggestions. Their cooperation is a valuable means of extending your business and is well worth your strenuous efforts to secure and hold.

Keep informed of the local work your architects have in hand and arrange for regular reports from the building inspector's office.

Knowing in advance of projected new buildings or remodeling work, you can furnish advance information to your friends, the contractors, and their self-interest in securing the work will make them effective solicitors for you.

PUBLICITY.

Make use of every legitimate means of securing desirable publicity for your company.

Establish friendly relations with the editors and reporters of your newspapers.

In most small towns, news items are not plentiful and much profitable publicity can be secured through tactfully acquainting your newspaper men of current happenings, such as contracts closed, contemplated improvements, etc., or handing them an occasional clipping describing some electrical appliance or some new application of electricity.

Should you, unfortunately, have an accident, prepare your own version for your papers. It will save them the trouble of writing it up and insure your public having the story as you want it told.

Remember, your business is bound to receive a certain amount of attention from the press. If you will make the effort, you can direct it to your advantage.

Make every piece of company property carry its advertising message. If there is no ordinance prohibiting it, put a permanent enameled sign on every one of your poles. You need not incur the expense of equipping all the poles at one time, but by buying permanent signs you can put them up on the instalment plan, without finding the expense too heavy a burden.

The benefit to be obtained by circulating a monthly bulletin among their customers and prospective customers is not properly appreciated by central station men.

Energetically pushing forward the many advantages of electric service, both to the customers and to the community as a whole, will do more than anything else to disarm the hostile spirit too often manifested against central stations.

There is no one to do this save the central station men themselves, and no better way to accomplish it than the monthly bulletin.

The practice of advertising appliances on or with monthly bills for service is of doubtful value. The recipient of the bill is then in the least receptive mood for suggestions to increase his use of current.

The bulletin method is more costly, to be sure, but it deserves careful consideration among your other plans for extending your business.

Give your wagons, tool carts, etc., especial attention. Paint them often and keep them clean.

Make your entire equipment carry its message of wide-awakeness and progressiveness to your community.

CULTIVATING POPULARITY.

Aim to be considered in your community as a public benefactor.

Use a portion of your new-business appropriation for purchasing advertising space in programs for church entertainments, etc.

The space so purchased has little advertising value, but when the character and energy of the people behind church and charitable organizations are considered, the importance of securing their good will is apparent.

The amount paid in each case need only be a small one, but it is important that this matter be so handled as to build up a cooperative spirit and that your customers appreciate that you are anxious to lend your assistance to anything promoting the public welfare.

In this line of work, beware of the professional advertising-scheme promoters.

If possible, arrange to loan cooking and other apparatus to church and charitable organizations free of charge, including current used. Stipulate, however, that a representative of your company shall superintend its operation to demonstrate the apparatus and to make use of any opportunity to promote your interests that may occur.

Never let any adverse criticism of your company, by any individual in your community, go unanswered.

Public service companies have so generally neglected to answer hostile criticisms that the public generally has come to consider that they have no answer.

Whenever you hear of a disgruntled individual, ascertain as quickly as possible what his grievance is, and either show him where he is wrong, or right his trouble. A few people you will find whom you can not convince, but your efforts in this direction, persistently followed up, will bear rich fruit.

CONCLUSION.

It would perhaps be difficult for any one man to follow all of the lines suggested, but every man doing central station work can, if he will, start with some one line of effort in this direction.

The start is the all-important thing, for, if the work be followed up, new ways and methods will be constantly suggested to the persistent worker.

Thoreau says: "I learned this—that if one advances confidently in the direction of his dreams he will meet with a success unexpected in common. If you have built castles in the air, your work need not be lost; that is where they should be—now put the foundation under them."

This also applies to the new-business work.

Dream your dreams of satisfied customers lighting their homes, their factories and their stores with your current, driving their machines with your power; cooking their meals with your appliances; advertising their business with your signs. Then work, work day and night to make your dreams come true.

Work—everlasting, never-tiring, patient, persistent work—that is the secret of a successful new-business department.

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

Single-Phase Induction Motors.

The field for the use of single-phase motors of moderate capacity is constantly growing by reason of the increasing tendency of central stations to generate polyphase current and feed a large portion of the lighting load through single-phase distribution. Power is frequently required near such circuits for the operation of light machinery, and this is conveniently furnished by the installation of the General Electric Company's type IS, form KG single-phase motors.

NEW TYPE GENERAL ELECTRIC SINGLE-PHASE INDUCTION MOTORS.

The new motors are of the same simple, sturdy design as the company's polyphase induction motors and are also similar in appearance. The frames are cylindrical in form with removable end shields, the position of which can be shifted 90 or 180 degrees for wall or ceiling suspension, respectively. The fields are made up of a large number of thin punchings of the best quality of soft steel assembled under heavy pressure between the end frames. Since this motor has no complicated, internal, automatic devices for starting, the resulting machine is of the simplest mechanical construction.

The armatures are of the high-resistance squirrel-cage type, consisting of a number of slotted soft-steel discs assembled upon a shaft and carrying in the slots copper bar windings, which extend beyond the core at each end and are permanently connected to short-circuiting rings. The windings are similar to those of a three-phase motor, consisting of a large number of coils placed progressively in the slots. Some of the motors are fitted with three terminals, while the others have six terminals. The feet of the one-quarter and one-eighth-horse-power motors are slotted to facilitate tightening the belt. With the larger motors iron sliding bases are provided for this purpose, although motors can be supplied without bases, if so desired. All bases are designed for supporting motors when installed on floor, side wall or ceiling. Motors of one horse-power and larger are fitted with clutch pulleys, so that they can be started under full load while drawing only two to two and one-half times full-load current. The clutch is so arranged that pulleys of various diameters may be substituted for the ones ordinarily supplied. This is accomplished by the use of a sleeve, in connection with the moving member of the clutch, on which the pulley itself is carried. The sleeve is slotted and arranged to take standard pulleys, which are held in place by a key and set screw. Should it become necessary to change the pulley, it can be readily removed and replaced by one of the desired diameter or by a pinion.

The motors are rendered self-starting by means of a starting-box containing a resistance and reactance and a double-throw switch. This is first thrown to the starting position, and when the armature has attained almost full speed it is quickly thrown over to the running position, the object being to first throw the resistance reactance in circuit with the motor and later to disconnect it.

In the case of motors provided with six leads, the winding connections are changed through the starting box at the time of throwing over the switch from Y to delta connection. By this arrangement a starting torque of approximately 150 per cent is obtained with 200 per cent of full-load current. The small motors without clutch pulleys develop a starting torque of approximately 125 per cent of full-load torque. The speed of an induction motor is regulated by the frequency of the supply circuit, and is not materially affected by variations of voltage, so that the motors will operate at full load at from two per cent to five per cent less than synchronous speed.

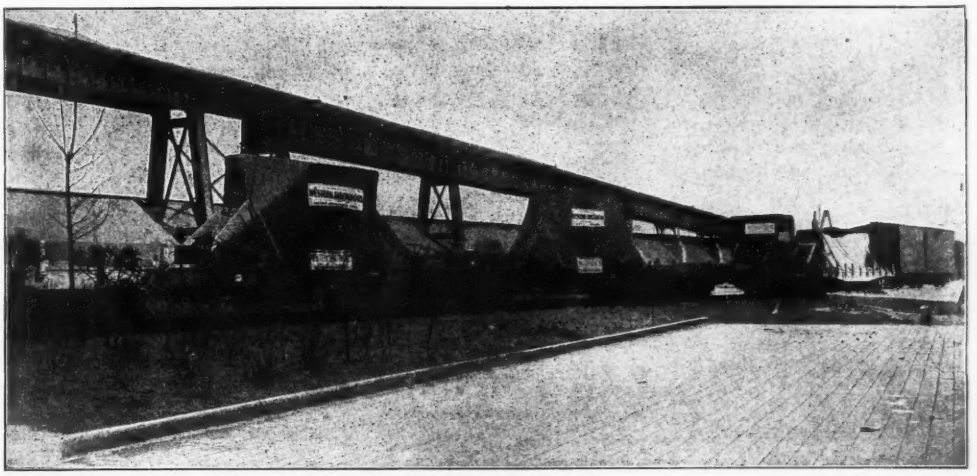
The standard motors are wound for 110 or 220 volts, sixty cycles, in sizes from one-quarter to five horse-power, inclusive. The standard winding for larger motors is 220 volts. Satisfactory operation can be expected over a range of voltage or frequency considered together of fifteen per cent either above or below normal. In addition, motors of all sizes with special windings and accessories for fifty-cycle, and from one-quarter to one horse-power, inclusive, for forty-cycle circuits, can be furnished to order by the General Electric Company.

When these motors are operated from the regular lighting circuits no appreciable effect is produced upon the lamps, provided the circuits are well laid out and supplied with sufficient transformer capacity; or, if preferred, they can be placed upon separate transformers. In either case, one kilowatt of transformer capacity should be allowed per horse-power of motors installed.

General Electric single-phase motors are well adapted to the operation of all kinds of machinery by means of belts and gears, or when direct-connected to loads requiring only moderate starting torque, as in the case of governors, blowers, etc., to which they may be direct-connected with rigid couplings. When greater torque is required at the moment of starting, as in case of pumps under head, clutch couplings should be used. When gearing is to be employed, the ordinary pulley can be removed from the clutch sleeve and a pinion substituted; this is preferably made of rawhide, in order to reduce the noise.

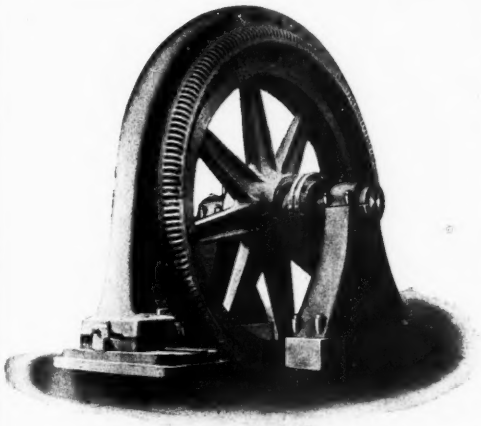
New Generators for the Ottumwa Railway and Light Company.

The accompanying photograph was recently taken in the railroad yards of the Western Electric Company at its new manufacturing plant at Hawthorne, Ill. The view shows a line of five cars, just loaded and ready to be moved, consigned to the Ottumwa Railway and Light Company, of Ottumwa, Iowa, which is remodeling and modernizing its power plant. The Ottumwa company has lately changed hands and is now under the management of H. M. Byllesby & Company, who are installing new apparatus to increase the capacity. This company furnishes power for both the Ottumwa Street Railway and the city's commercial and street lighting systems.



Consignment for the Ottumwa Railway and Light Company Leaving Railroad Yards of the Western Electric Company, Hawthorne, Ill.

These cars are loaded with two Western Electric generators. The first is one of the new type R revolving-field alternating-current generators of 500 kilowatts' capacity, 1,150 volts, three-phase engine type, operating at 100 revolutions per minute, a view of which is shown herewith. This machine embodies in its design the latest ideas in the art of designing alternating apparatus. The ventilating spaces



Western Electric Engine-Type, Revolving-Field, 500-Kilowatt, 1,150-Volt, Three-Phase Generator.

provided at frequent intervals ensure uniform and minimum temperature of the core, and by the arrangement of the coils at the end of the stator the windage of the rotor is utilized for ventilation of the armature coils, as well as the core, thereby preventing excessive or injurious rise of temperature under heavy overload.

The second machine referred to is a 500-volt, direct-current railway generator. This machine is one of the Western Electric Company's well-known type L generators, so many of which are used by street railway companies throughout the country. This is also of 500 kilowatts' capacity of the engine type and will operate at 100 revolutions per minute.

Enlargement of Equipment of the Locke Insulator Manufacturing Company, Victor, N. Y.

The rapid expansion of the business of the Locke Insulator Manufacturing Company, Victor, N. Y., has taxed to the utmost all the facilities of the old power plant, until at the present time the construction of a new and larger one has become imperative.

The new building, for which foundations have already been laid, is to be ninety feet by ninety feet, of approved concrete construction; one side being parallel to, and fifteen feet below, the tracks of the New York Central & Hudson River Railroad, enabling hard and soft coal to be unloaded directly to the bunkers.

The boiler room, which measures approximately forty-five feet by ninety feet, will contain 600 horse-power in horizontal tubular boilers, hand-fired with a mixture of buckwheat and soft coal, necessary draught being provided by a large engine-driven fan.

Engines, generators and high-tension testing transformers will occupy the remainder of the building. There will be two power units, one for day load and a smaller one for night load, the demand for power being practically continuous. The smaller unit of sixty kilowatts' capacity is made up of a Skinner engine running at 300 revolutions per minute, direct-connected to a three-phase sixty-cycle, 440-volt alternator. The larger unit, a low-speed Corliss, will be direct-connected to a three-phase, sixty-cycle, 440-volt alternator of 150 kilowatts. These two machines will supply light, power and current for testing all through factory as well as supply power for street and residence lighting in the village of Victor.

The plant has been laid out for the most economical working under the peculiar conditions existing in an electrical porcelain pottery, and while the present plans as outlined will provide ample power for the present needs, provision has been made for future increase.

Meeting of the Sales Managers and Representatives of the Buckeye Electric Company.

During the week of August 20 the sales managers and representatives of the Buckeye Electric Company, Cleveland, Ohio, held a three-day meeting at Cleveland. The representatives of the company all expressed themselves enthusiastically concerning the year's business and the prospects for a large demand for the coming season. The company announces that it has been working at its fullest capacity in order to create a supply of stock which would place it in a position to make instant shipments of orders of any magnitude. The Buckeye tantalum twenty-two-candle-power lamp, the focal type "Gem" lamp and the high-efficiency, high-candle-power "Gem" units manufactured by the company are all meeting with great success and the company expects a very large business during the coming year.

Meeting of the Shelby Electric Salesmen's Association.

The accompanying illustration shows a group picture of the sales department force of the Shelby Electric Company, Shelby, Ohio. The company has organized the Shelby Electric Salesmen's Association, including the personnel of its sales departments. C. W. Cartwright, of the Boston office, is president of the association; W. E. Groves, Philadelphia, vice-president; J. G. Van Horn, Shelby office, secretary. The company holds a meeting each year and the entire corps of factory employés is taken to some resort along Lake Erie for an outing. At these meetings everything pertaining to the lamp situation is gone over. The company endeavors to take into consideration the desires of the users of incandescent lamps when framing its policy for the year's work. The company is very widely represented; in fact, it is asserted that its representation is the most complete of any exclusive lamp manufacturer in the country.

Convention of Office Representatives and Branch-Office Managers of the Shelby Electric Company, Shelby, Ohio.

Reading from the right the make-up of the group is as follows: J. R. Dudley, Buffalo; W. Love, Michigan; E. H. Allen, Louisville; William Ellis, Portland, Ore.; C. W. Cartwright, Boston; J. C. Fish, president of the Shelby Electric Company, Shelby; W. E. Groves, Philadelphia; F. M. Haskell, eastern Pennsylvania and New Jersey; George W. Sheeler, Baltimore; C. A. Schettler, Cleveland; F. M. Brown, Pittsburg; George Austry and H. W. Strock, Indianapolis. Directly behind Mr. Strock is T. P. Gleeson, and then F. B. Smiley, St. Louis; Col. Jonas Feighner, Ohio; P. M. Fletcher, New York city; J. G. Van Horn, Shelby; W. S. Reynolds, Detroit; H. K. Bowman, Cincinnati; George Loring, New York city; C. M. Hopwood, Wisconsin; R. P. Bricker, Shelby; G. W. Fowler, western Indiana; C. C. Skiles, W. W. Van Horn and W. H. Myers, Shelby; W. P. Clawson, Chicago; O. D. Pierce, San Francisco.

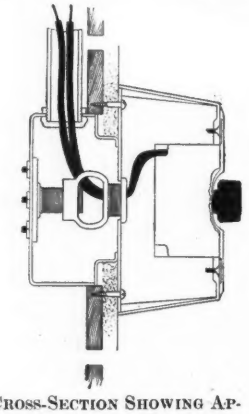
The Gleason Universal Moulding Box.

The Gleason universal moulding box, made by John L. Gleason, 290 South street, Jamaica Plain, Mass., illustrations of which are shown herewith, is designed to facilitate the mounting of any fitting for electrical purposes in conjunction with moulding work. Any flush switch or receptacle will fit this box, and its flush plate will just cover the face of the box. For mounting surface fittings, such as safety switches, wall sockets, rosettes or bracket or pendant tubes, a universal lid is furnished. This feature is shown in the accompanying illustrations. For use as a junction box a blank lid is furnished in place of the universal lid.

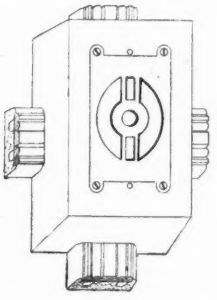
For connecting to a conduit system an orifice is left in the back of the box, where the conduit may enter, and the box is fastened to the conduit system with a conduit bushing making up against the back plate. These back plates are separable, so that if it should be necessary to enlarge any of the moulding ports to use a three-wire moulding or any unusual size, it would facilitate the use of a hack saw, file or emery wheel in making the alteration in the ports. The moulding ports are steel chills shrunk into the iron. The chill may be knocked in or knocked out, leaving a perfectly clean port, without detriment to any other part of the box.

These appliances are sufficiently deep to allow for the conduit bushing and wires under the deepest push-button switch or flush receptacle. The appliances are also useful for protecting flush receptacles on floors, the conduit entering from underneath.

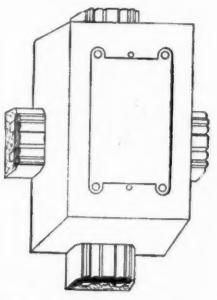
Mr. Gleason also manufactures a similar box arranged for exposed iron conduits.



Cross-Section Showing Application to Concealed Outlet on Wall or Ceiling with Flush Switch Mounted.



Perspective View, Showing Universal Lid.



Perspective View, Showing Blank Lid

The "Star" Toggle Bolt.

The accompanying illustrations show the application of the "Star" toggle bolt, manufactured by the Star Expansion Bolt Company, New York city, for making fastenings to tile, hollow brick, metal, thin marble, wood, and metal or wire lathing.

The "Star" toggle bolt consists of a head and a regular machine screw. Any machine screw will fit the toggle heads.

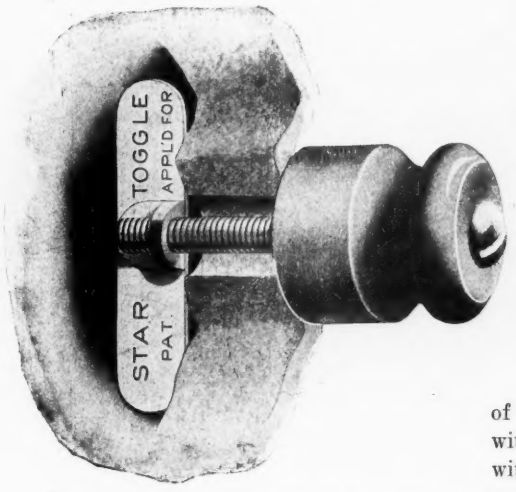


FIG. 1.—"STAR" TOGGLE BOLT INSERTED IN WALL.

Fig. 1 shows the toggle bolt being inserted into the wall. The screw is put through the article to be fastened and into the nut in the toggle head. The toggle is inserted through the hole in the wall and fastened tight, and, after having turned, automatically adjusts itself in place.

Eureka Electric Flat-Irons.

Probably no form of electrically heated apparatus for domestic service has won so wide and rapid a popularity as the electric flat-iron. The numberless little conveniences which can be effected with this apparatus has gained for it instant recognition.

One of the most successful irons on the market to-day is the line designed and made by the W. J. Barr Electric Manufacturing Company, of Cleveland, Ohio. This company, in addition to a wide range of electrical heating apparatus, manufactures the "Eureka" line of flat-irons in thirty different styles, ranging from the diminutive traveler's iron, weighing three and one-half pounds, to the thirty-pound tailor's goose.

Not a little of the success of this line of irons is due to their attractive appearance. The irons are designed on artistic lines, and the heavy nickel finish ensures a lasting good appearance. Because of an improved form of construction the makers are able to claim a very high efficiency and a great length of life. In fact, it is stated that, with reasonable care the heating element in the "Eureka" iron will last at least ten years. A feature of this apparatus, however, is the ease with which renewals may be made, if, through accident, this should be desirable. The top

"EUREKA" ELECTRIC FLAT-IRON.

of the iron has no electrical connection with the bottom, and the heating element with its cord connection may be easily removed with a screw-driver.

Another feature of the design is the arrangement of the heating coil. This is so placed that heat is delivered without loss to the surface where it is needed, the coil covering the entire bottom and extending into the point, where for certain kinds of work a well-heated surface is essential.

A patent spring cord-protector takes the strain where the cord enters the iron and eliminates wearing at that point.

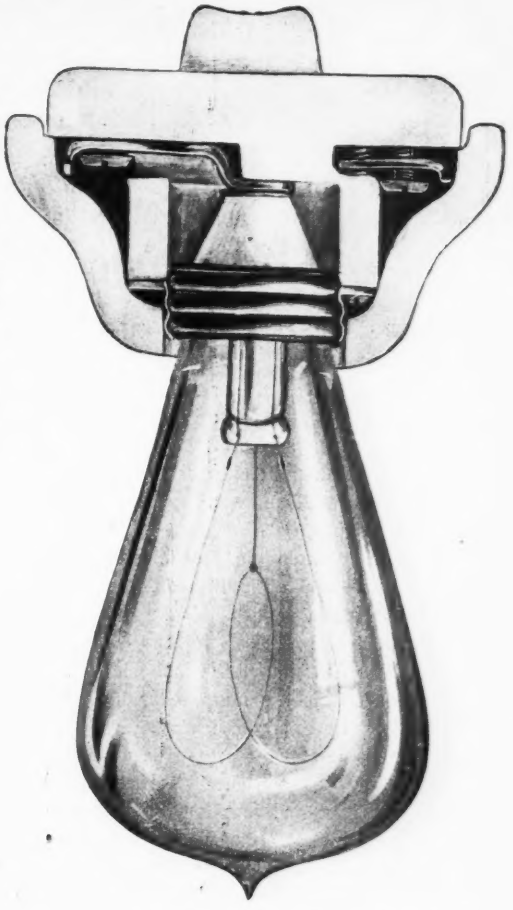
"EUREKA" ELECTRIC FLAT-IRON WITH AUTOMATIC CUTOUT.

Where conformity to the underwriters' rule necessitates an automatic cut-off when the iron is not in use, the patented device for accomplishing this, recently brought out by the company, will satisfy this condition. This automatic cut-off is placed in a small box, conveniently placed, and heavily nickeled, and fitted with a removable face-plate, facilitating examination and repair.

In line with the development now taking place throughout the country, the company has worked out a plan for cooperating with central stations in the introduction and sale of these irons and other apparatus, which is meeting with a vary satisfactory measure of success.

Weatherproof Incandescent Lamps.

The accompanying illustrations show an incandescent lamp and socket placed on the market by the Rooney Electric Lamp Company, 155 East Twenty-third street, New York city, for use particularly on circuits where conditions of exposure render a weatherproof installation



WEATHERPROOF INCANDESCENT LAMP AND WEATHERPROOF SOCKET.

necessary. Thus, for signs, spectacles, outdoor decorations and the like, these lamps and bases will be especially applicable.

As may be readily noticed there is a considerably increased insulating distance

between the metal parts of the lamp base. Glazed porcelain buttons are used as separators, these shedding the moisture, and the non-absorptive properties eliminating the danger of electrolytic action or short-circuit.

An interesting application of these lamps is found at Luna Park, Coney Island, where it is customary in cleaning to flush the board-walks around the lagoon with salt water. In draining off the walks the salt water runs over the lamps around the sides of the lagoon, so a special socket is used, extra thicknesses of porcelain being used between all live parts of the device, and the socket is so constructed that it sheds water very readily.

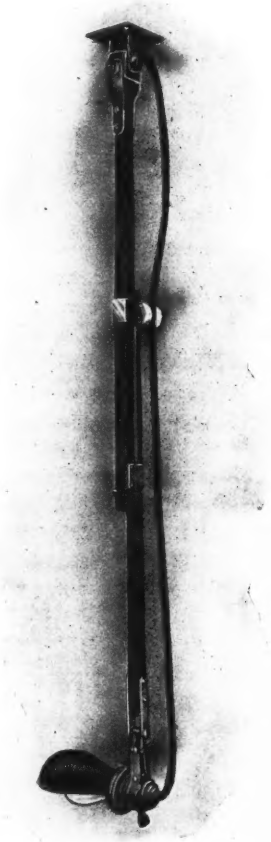
Prior to the installation of these sockets and bases numerous circuits were found defective after every heavy storm, but since the change has been made these troubles have been in large part eliminated. The lamps can be used in Edison sockets without any change.

Adjustable Incandescent Lamp Fixtures.

The Gail-Webb Manufacturing Company, Buffalo, N. Y., has placed on the market a complete line of adjustable fixtures and portables for use with incandescent lamps in shops, offices, draughting rooms, etc.

The Universal electric light holders, one of the company's products, is shown in the accompanying illustration. This form of fixture is designed to meet the demand for a thoroughly practical and durable low-priced adjustable fixture for shops, draughting rooms, etc. It allows the lamp to be swung to any point within a circle ten feet in diameter, to be raised or lowered through a distance of half the length of the holder and twisted and turned to any conceivable angle. Automatic friction clamps at all joints enable the lamp to be moved into any position and to stay wherever placed. The holder has recently been improved by using case-hardened steel swivel joints in the universal joints, wing nuts on the lower joint, and offset bands at the sliding joint, allowing free motion of the wooden rods under all conditions. The use of this fixture in shops not only does away with all temptation for the workman to tie his lamps back with strings or to hang the drop-cords on nails or on the machinery itself—a common source of danger in many shops—but also allows the light to be brought to any desired point and protects the workman's eyes while giving direct light on his work. In draughting rooms this device is of great service in furnishing the light at any point over the drawing board. It is made in three finishes, plain black, nickeled or oxidized.

Another style, a neat and attractive adjustable wall fixture, is manufactured by this company, the main features of which are also incorporated in an adjustable ceiling fixture and an adjustable portable. The wall type, which is two and one-half feet long when telescoped and four and one-half feet extended, has a ball-and-socket joint at the upper end, allowing the rods to stand at any angle, while the joint at the lower end and the sleeve attached to the arm afford means of turning the lamp in any direction. Once adjusted, the joints require no further attention. The ceiling type differs from the wall type only in the bracket, which is made suitable for ceiling attachment; and in the lengths of the arms, these being varied to suit different heights of ceilings.



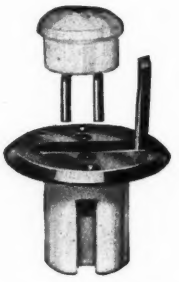
Adjustable Incandescent Lamp Fixture.

The portable has the ball-and-socket joint at the base and the same means of turning the lamp as are used in the wall and ceiling types. It is provided with a neat iron base, sufficiently heavy to ensure stability under all conditions.

These fixtures are proving very desirable for offices, draughting rooms, etc.

New Type Midget Plug and Receptacle.

The Marshall Electric Manufacturing Company, Boston, Mass., has recently made improvements and alterations in its No. 521 midget plug and receptacle, which is now furnished with larger holes to take the ordinary screw-driver for fastening the cord wires.



Midget Plug and Receptacle.

The points of the plug contact are also tapered for quick insertion in the receptacle. Where desired, these receptacles are also furnished with an insulating paper sleeve around the receptacle which can be easily rotated to expose the contact wires and screws.

These receptacles are carried in stock at the New York office, 227 Fulton street, and the Chicago office, 169 Adams street, of the Marshall Electric Manufacturing Company, as well as at the Boston works.

The Buckeye Two-Cycle, Single-Acting Gas Engine for Generator Driving.

The Buckeye Engine Company, Salem, Ohio, has developed a new type of two-cycle scavenging and single-acting engine particularly adapted for direct-coupled generator driving, and fed by suction producer-gas. The engine will work equally well with other fuels, such as natural, illuminating and blast-furnace gas, gasolene, distillate, etc. The engine here described is built in sizes from twenty-five brake-horse-power to 500 brake-horse-power. For powers above 500 brake-horse-power the Buckeye Engine Company builds double-acting engines of both the two and four-cycle types, of any capacity required.

The single-acting engine has two motor cylinders, two fuel-pumps, and two air-pumps, and is equipped with two cranks set 180 degrees apart. This gives two

working impulses to each revolution of the crank shaft. The cranks are exactly opposed, and are equipped with two sets of pistons of equal weight, the engine needing no counterweighting and turning with a nearly perfect running balance.

ber (1) through valve (11) and port (19), forcing out the spent gases. A section through the combustion chamber at AA is circular, and the conical form of the combustion chamber assists in spreading the scavenging charge evenly behind the

When piston (2) has covered ports (14) on the return stroke the compression begins in the motor cylinder, provided valve (10) has closed; this feature being discussed later.

The compression being complete, the

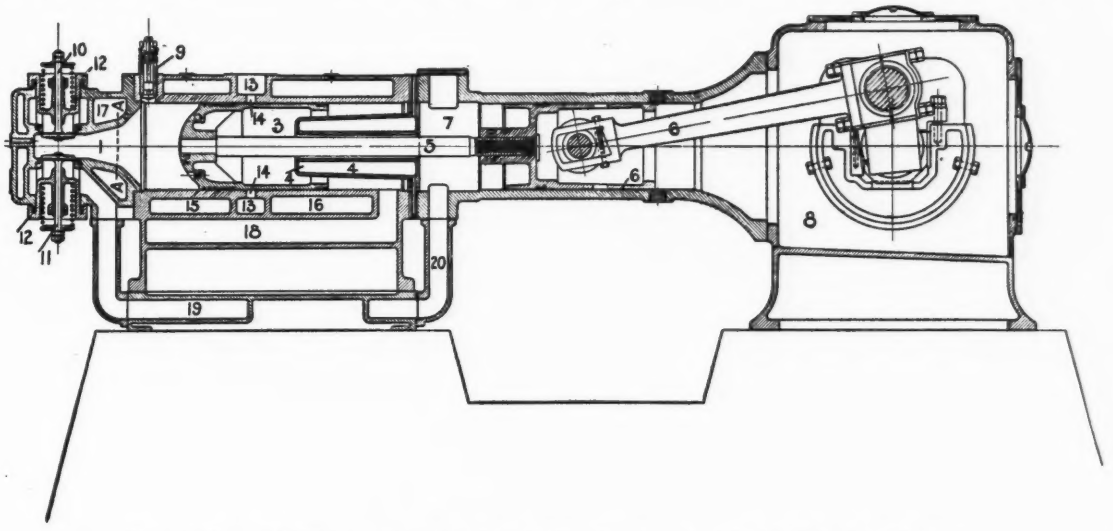


FIG. 1.—VERTICAL SECTION THROUGH ONE MOTOR CYLINDER, ONE GAS AND ONE AIR PUMP.

The cycle of operation is as follows:

The piston in crosshead barrel (46) Fig. 2 furnishes air at a pressure of about eight pounds per square inch for scavenging combustion chamber (1), Fig. 1, and piston in crosshead barrel (45), Fig. 2, compresses air at the same pressure

spent charge. Somewhat later, valve (10) opens, admitting into the cylinder a charge of explosive mixture which has been compressed in chamber (3) in front of piston (2). It is thus seen that each motor piston compresses its own explosive mixture but receives its compressed air for

charge is fired in the usual way, firing occurring alternately in the two motor cylinders.

A valuable characteristic of this engine is that so much sought for by all intelligent gas engine designers, namely, constant compression and constant mixture

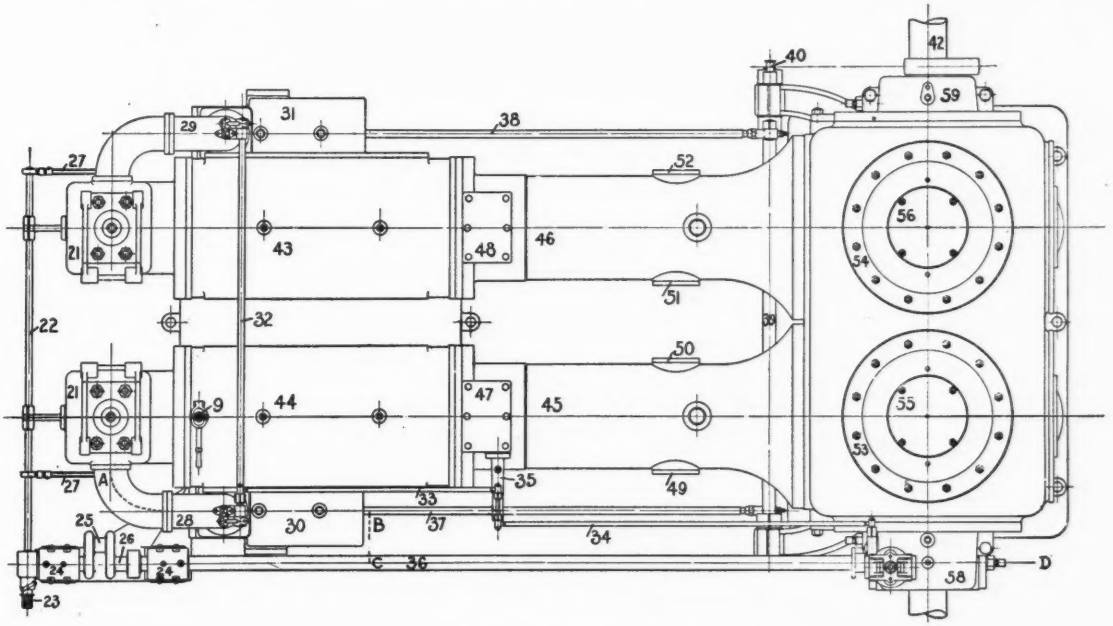


FIG. 2.—PLAN OF ENGINE.

for scavenging combustion chamber in cylinder (43), Fig. 2. Assuming Fig. 1 to be a section through the right-hand engine, and piston (2) just uncovering ports (14), Fig. 2, enters the combustion cham-

scavenging from the opposite engine. Since valves (10) and (11) are independently driven, the relative timing of the admission of the scavenging air and the mixture is under perfect control.

at all loads combined with quick and certain response to sudden change of load.

The quantity of air passing through the air-pumps is constant at all loads, but the amount of air and gas handled by the

fuel-pumps varies according to the load carried.

There are two sets of igniters in each combustion chamber and the engines are also provided with jump spark ignition apparatus. The change from one system to the other can be made in a few minutes' time.

The head is equipped with a water-jacketed sleeve. This sleeve is babbitted and bored out, and on account of its considerable length, the speed of reciprocation, and low pressures on either side, there is no leakage through the sleeve and it is subject to no wear.

In the wrist end the connecting rod has wedge adjustment, and in the crank end is of the marine type.

The main bearings are fitted with babbitted shells of ample area and have complete means for alignment and taking up wear.

The crosshead pistons and main bearings are oiled by splash oiling. The spiral gears driving the lay shaft are immersed in oil. Bearings for the valve cranks and cranks for operating fuel-valves have ring oilers.

On account of the combined cooling action of the water jackets and the scavenging air, a very high degree of compression can be carried. Another important feature in this engine is that expansion can be carried to any point whatever. The fuel-valve can be so set that the compression may begin, say, at half stroke; in this case expansion would be to twice the volume admitted. In the smaller sizes this feature will not be made use of, but in the larger sizes an increased thermal economy is thus available.

Suction producers require a variable amount of draught in their operation, due to varying conditions of the fuel-bed. Here advantage is obtained, since the fuel-pump in this engine has ample capacity to supply the engine with fuel, no matter what the draught may be within large limits, and a producer can in emergencies be forced beyond its rated capacity without seriously diminishing the power of the engine.

The engine is also self-cleaning, making it unnecessary to take off heads and valves for cleaning. All dirt is blown out, and after many months of continuous service on suction producer-gas the combustion chamber has been found absolutely clean.

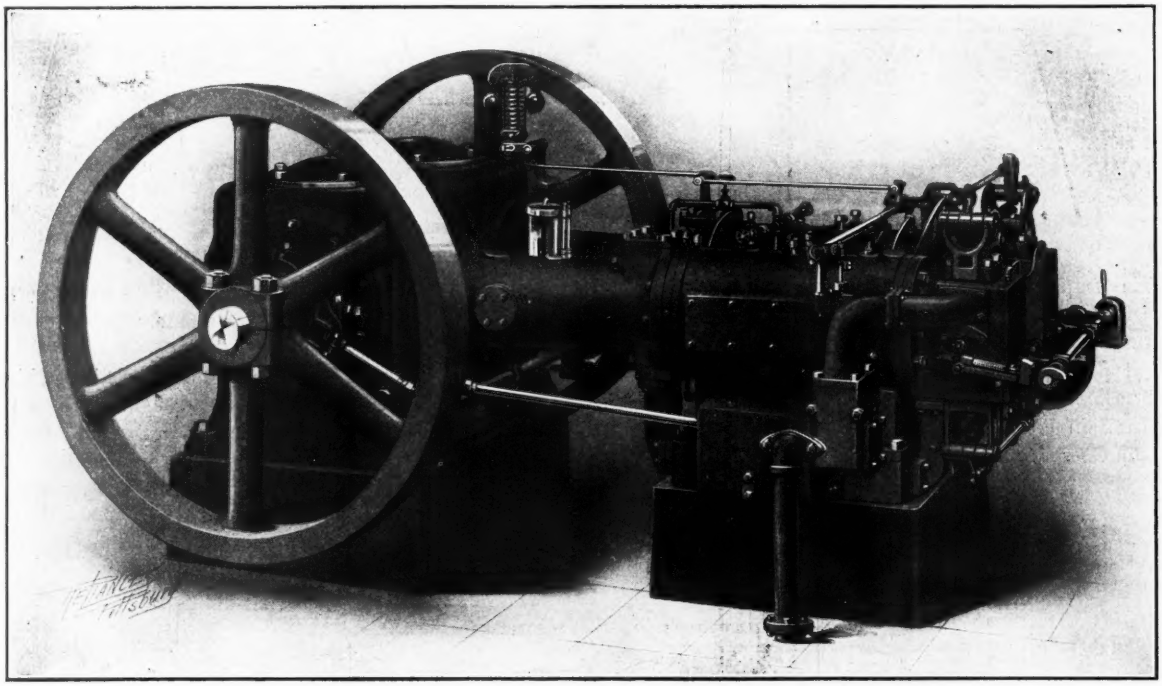
An engine of about seventy-five horse-power, with cylinders of nine inches diameter by twelve inches stroke, has been found by repeated tests to develop a mechanical efficiency over eighty-five per cent, the pump-work being included as friction.

The directors of the Midland Railway, England, have approved of a scheme to convert a portion of their line to electrical working. The full details of the project are not yet settled, but it is said that the commencement of the scheme will be the equipment of the lines between Lancaster, Morecambe and Heysham Harbor, and that a single-phase system will be adopted.

National Air-Compressors.

The National Brake and Electric Company, Milwaukee, Wis., has completed a new line of motor-driven compressors, several views of which are shown in the accompanying illustrations. This compressor differs from other types in that the motor is placed on top of the crank chamber. The motor and compressor are both separate, self-contained and distinct units, making the complete compressor a compact and rigid unit. The motor bearing at the pinion end forms a cover for the top of the gearing. There is a one-half-inch space between the crank chamber cover and the motor base, which prevents the heat being communicated from the compressor to the motor. This separate cover for the crank chamber provides the necessary bracing and stiffening for the crank chamber casting.

The crank shaft is provided with a third bearing in the centre, which steadies the crank shaft and supports it at its weakest place, doing away with any tendency of the shaft to fracture in the centre. The compressor runs very quietly and free from vibration with this third bearing, and the efficiency and life of the pump and gearing are materially increased. The crank shaft and gear are removed by lifting them straight out of the crank chamber, it being unnecessary to first remove the gear from the shaft. This increases the accessibility of the pump and



TWO-CYCLE, SINGLE-ACTING GAS ENGINE BUILT BY THE BUCKEYE ENGINE COMPANY, SALEM, OHIO.

considerably reduces the time of taking apart and putting together again.

The standard method of splash lubrication is used for the working parts of the compressor. The gear and crank move in a bath of oil and splash it all over the moving parts of the compressor. The gear case is cast as an integral part of the crank chamber, making a very rigid pump base and reducing the number of loose parts.

The compressor is a standard two-cylinder, double-action type with trunk pistons. The piston rings are of the Dunbar type. The sections of the rings are carefully fitted by hand, and the complete ring is then ground true. The pistons are each provided with one piston ring. The piston wrist pin, on which the tail end of the connecting rod works, is of hardened steel ground true and pressed into place. The connecting rod head is connected to the body of the rod by means of a hinge and hinged I-bolt.

The discharge valves are placed toward the centre, and the suction valves toward the outside of the head. The discharge pipe goes straight out from the valve head to the main reservoir, there being no necessity for attaching elbows. The suction has two openings, one at each side of the valve head. Either or both can be used. They are provided with straining screens, and the air can either be taken straight into the cylinder or piped from the inside of the car or from the car roof. The suction and discharge valves are interchangeable and are of solid cold-drawn tubular steel, being seated by gravity aided by air pressure, and no springs nor auxiliary devices are required.

The gear and pinion are a standard herring-bone pattern with fine teeth. The gear is of open-hearth cast steel, and the pinion of high carbon steel. They are made in two halves and riveted together.

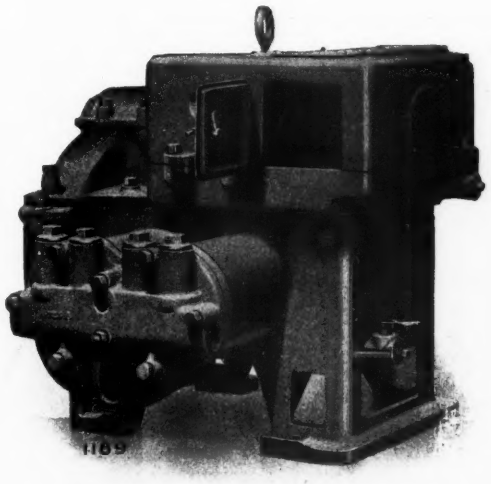
The lower half of the motor magnet frame is a steel casting, which also carries the bearings and forms a cover for the upper half of the gear. The diameters of the shaft and bearing at the pinion end have been increased. An oil-thrower has been attached just inside of the pinion end so as to prevent the oil from the gear and pinion working into the armature bearing and flooding the motor.

The motor is of the company's standard four-pole, consequent-pole type, with series-wound armatures. Two field coils are arranged in a horizontal plane to reduce the overall height of the motor compressor. The field coils can be quickly removed, the one by merely taking off the top half of the motor, and the other by taking off the top half of the motor and removing the armature.

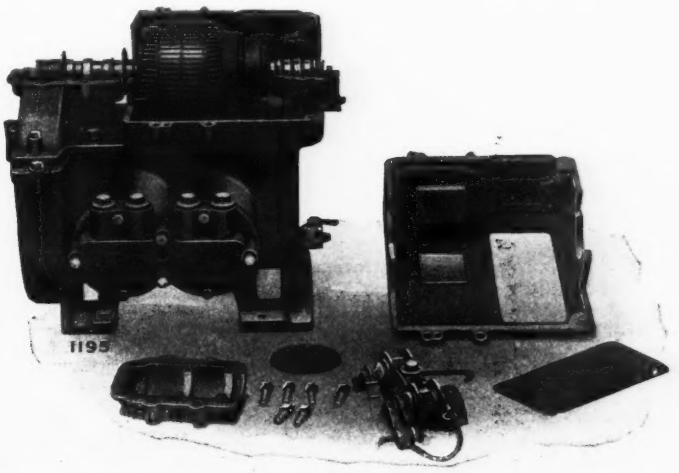
Particular attention has been paid to the designing of the brush gear, notably in regard to the insulation. Compressor motors operating under a street car are liable to get covered with oil and dust, and unless the insulators have ample margin they will not last. In the new type of brush-holder the insulation has been liberally designed. The external leakage surface is about one and one-quarter inches. An insulating shield has also been provided between the bearing and commutator to prevent any chance of a flash-over at that point. The brush-holders have been provided with an improved patented spring tension which is constant over a wide range and is capable of being easily and accurately adjusted.

The motor is completely encased to protect it from the weather and do away with the necessity of enclosing the motor in a suspension box. Inspection doors are provided on the side of the motor casing, and a hand hole on the top of the motor casing for examination of the commutator and brushes.

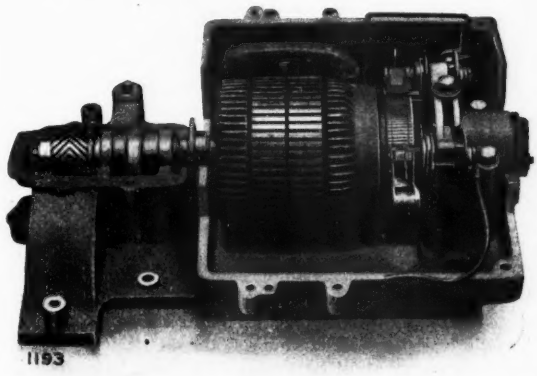
The arrangement of oil-filling and oil-drain holes is such as to be convenient and sightly. The vent holes for the crank chamber are cast in the side of this chamber, being suitably protected to prevent any danger of oil splashing out, and are of sufficient area to do away with any tendency to force the oil vapor and oil from the crank chamber into the motor bearing and armature.



TYPE A-4 NATIONAL AIR COMPRESSOR COMPLETE.



UPPER HALF OF MOTOR FRAME REMOVED, SHOWING ACCESSIBILITY.



LOWER HALF OF MOTOR.

Current Electrical News

DOMESTIC AND EXPORT.

CABLE TO ICELAND—The Great Northern Telegraph Company has completed the laying of its cable connecting Iceland with many far-away points, and the line has been opened for public service. The cable that will connect Iceland with the Danish capital will be opened October 1.

TO DEVELOP BIG BEND WATER POWER—R. Cross, of Spokane, president of the Big Bend Water Power Company, recently incorporated for $1,500,000, to develop power on the Spokane river, twenty-eight miles from Spokane, announces that Spokane and eastern capital is interested in the project and that a largely increased force will soon be at work on the dams and spillways. It is purposed to build a sixty-foot dam, a modern power-house and develop 16,000 horse-power. Mr. Cross says this can be done at a cost of $21.90 the horse-power.

KENTUCKY ELECTRIC COMPANY INCORPORATED—The Kentucky Electric Company, with a capital stock of $500,000 has filed articles of incorporation at Louisville. The incorporators are Lawrence Jones, Saunders P. Jones and Donald McDonald. The new company is organized for the purpose of taking up the Atherton-Jones ordinance, giving the parties named the lighting contract of the city. Peter Lee Atherton is the heaviest stockholder. This lighting franchise was sold at public auction on August 20 to Lawrence Jones, the highest bidder, for $100,150.

COST OF IMPROVEMENTS AND REBUILDING OF THE UNITED RAILWAYS AND ELECTRIC COMPANY—The effort being made by the United Railways and Electric Company to better its power facilities directs attention to the work done by the company since the fire. Not only has it provided new cars for most of its lines, but practically all of its track has been reconstructed. In addition, much special work has been accomplished. The expenditures might be summarized about as follows: cars, $2,250,000; tracks (including special work, $1,400,000); improvements to power plant, $1,000,000.

ADDITIONAL ELECTRIC POWER FOR BUFFALO—By October 1 the Cataract Power and Conduit Company expects to bring to Buffalo from the Canadian side 24,000 additional electrical horse-power, thus making its daily supply at least 75,000 horse-power. The extra energy will be brought over a transmission line 210 feet over the Niagara river, strung between two towers now being erected. From the towers, one on each side, the line will drop into a transformer station which the power company is erecting adjacent to the old Niagara street-car barns. The power will come from the power-house of the Canadian Niagara Power Company at Niagara Falls.

POSSIBLE MONOPOLY OF PEND D'OREILLE POWER—It is stated that rights to every pound of power in the waters of the Pend d'Oreille river between Big Falls, northeast of Spokane, and the international boundary, has been cornered by the Pend d'Oreille Development Company, of which David T. Ham, of Spokane, is president, and George S. Canfield, who has just completed an investigation and preliminary survey, estimated that at least 100,000 horse-power can be developed, with the cost at a minimum compared with other powers. The natural fall of the river through "Z" canyon is from sixty to eighty feet, and there is a possible fall of approximately 250 feet for power. The concern, which is backed by Spokane capital, purposes building a large plant and transmit power as far north as the boundary.

NEW EQUIPMENT FOR GUADALAJARA, MEXICO—La Electra, S. A., the Spanish light, power and street railway company, has placed orders for equipment and supplies for the electric street-railway system of this city that aggregate in value more than $500,000. The order for cars for the new street-railway system goes to the McGuire-Cummings Manufacturing Company, of Chicago. This concern will build forty cars at an approximate cost of $6,000 each. The cars will be thirty feet long and will weigh more than eight tons each. The United States Steel Products Company will supply the iron trolley poles and copper wire for the new system. Poles to the number of 1,800 have been ordered. The necessary copper wire will cost about $200,000. The dynamos, switchboards and other electrical equipment required for the operation of the street-car lines will be purchased from the General Electric Company. There will be three dynamos of 600 horse-power each, and two dynamos of 200 horse-power each.

COLORADO LIGHTING PLANT CHANGES OWNERSHIP—The Standard Light and Power Company has bought the plant of the Durango Light and Power Company, which is said to be worth $300,000. The Standard is a new company which recently obtained a franchise and intends erecting a new plant to be run by water power, obtained from a reservoir, the water for which will be taken from Junction and Hermosa creeks. The new plant will cost $250,000. The new company will operate the old plant until the new one is finished. By the terms of the franchise, the Standard company has six months in which to commence work and twenty months to finish. The present plant is operated by steam and will be kept in readiness to start whenever there is a breakdown. The Standard people say they will hold their franchise, and by doing so must make a reduction in light and power rates of about thirty-three and one-third per cent by the provisions of the franchise. The Durango Light and Power Company has furnished light for Durango for twenty years.

DAMAGES FOR McCALL COMPANY IN CONDEMNATION PROCEEDINGS—The jury in the condemnation proceedings instituted by the Susquehanna Electric Company against the McCall Ferry Power Company to value a strip of land along the river has concluded the matter by awarding the McCall company $56,000 damages, the railroad company $500 and each tenant in the houses who will be compelled to vacate $50. The Susquehanna company is a Maryland corporation which owns the old paper mill property and is the successor to the Susquehanna Water Power Company. The Harford company needed the land of the McCall company for the purpose of backing water from its proposed dam, which is contemplated to develop 25,000 horse-power to furnish electricity to Baltimore, Havre de Grace and Wilmington. The Susquehanna Power Company proposes to build its plant in Maryland, south of that of the McCall Ferry company, which is near the Mason and Dixon line. This company is a corporation separate from the Susquehanna Electric Power Company. The latter company owns property below that of the Susquehanna Power Company, and as yet has made no move toward erecting a plant.

NEW TRANSMISSION LINE FOR THE UTICA GAS AND ELECTRIC COMPANY—An electric power transmission line, which the Utica Gas and Electric Company has had under construction for a couple of months, has been completed. The company has started to transmit power eastward, through Frankfort to Ilion, Mohawk, Herkimer and Little Falls. About 1,000 horse-power has been supplied without interruption, and this will be increased by degrees. With this line completed, there have been connected the Trenton Falls power station of the Utica Gas and Electric Company and the Dolgeville water-power station of the Herkimer County Light and Power Company at Little Falls. But very little work is to be done to connect the Little Falls company with the transmission lines of the East Creek Electric Light and Power Company, thus forming a continuous transmission line from Trenton Falls to Canajoharie, a distance of about fifty miles. The electric plants in this territory are being materially increased, and eventually the combined plants will have an aggregate capacity of upwards of 35,000 horse-power. Later, a station on Fish creek, near Rome, will supply an additional 7,000 horse-power. The general plant of the transmission line contemplates extending as far west as Oneida, taking in Rome and intervening villages, and as far east as Amsterdam and Schenectady.

OBITUARY NOTES.

MR. CHARLES R. FABEN, manager of the Toledo (Ohio) Gas, Electric and Heating Company, died suddenly at Toledo on August 28, of heart trouble.

MR. E. T. HANNAM, inventor of the "Atlas" water-tube boiler, died at Chicago, Ill., at four P. M., Saturday, August 18. Mr. Hannam was about to enter a train with Mr. J. P. Johnston, of the Atlas Engine Works, to go to the latter's home at Evanston. His death was due to heart disease. Mr. Hannam had been connected with the Atlas company for the past three years, and had grown steadily in the esteem of his associates, being recently promoted to assistant manager of sales of the water-tube boiler department. He was just entering upon his new duties when he was stricken. His death is a distinct loss to the company, and will be regretted also by a host of friends and admirers.

LEGAL NOTES.

LIABILITY OF COMPANY IN AFFORDING PROTECTION TO A STRANGER—A corporation engaged in the generation of electricity is held, in Ryan *vs.* St. Louis Transit Company (Mo.). 2 L.R.A. (N.S.) 777, to be bound, upon contracting with a stranger for the performance of work within its buildings, to keep its wires so protected and insulated as to be safe for the latter's workmen.

DOBROWOLSKY PATENT SUIT—The United States Circuit Court of Appeals for the Seventh Circuit has handed down a decision affirming the lower court in the case of the General Electric Company *versus* the Kuhlman Electric Company. The suit refers to the alleged infringement of the Dobrowolsky patent No. 422,746, owned by the General Electric Company. The Kuhlman company was manufacturing polyphase transformers, in which the cores of the different elements were combined in an integral structure. The patent was sustained by the United States Circuit Court, and the Kuhlman structure held to be an infringement thereof.

NEW MANUFACTURING COMPANIES.

CAMDEN, N. J.—The Flasher Sign Company has been incorporated to manufacture and deal in electrical signs. The capital is $50,000, and the incorporators are: R. E. Thompson, Jr., L. A. Wilkins and Wilfred B. Wolcott.

NIAGARA FALLS, N. Y.—The Kirkwood Electrical Company, of Niagara Falls, has been incorporated at Albany with a capital stock of $10,000. The concern intends to do general contracting and electrical work of all kinds. The directors of the company for the first year are: William C. Winchester and Robert L. Laven, of Niagara Falls, and Nathan H. Jewett, of Buffalo.

ELECTRICAL SECURITIES.

A monetary stringency effectually checked the bull campaign which has been swinging along without abatement for several weeks. Along with this stringency a significant feature was the decrease in outside public interest in the market. At present it appears as if the stock market's development will be mainly guided by monetary conditions. It is unfortunate that this has come on the eve of the marketing of what promise to be the largest crops on record, and matters are further complicated by the understanding that general trade and commerce is in a remarkably strong position. There are, however, many well-founded hopes that a large gold import movement and relief from the United States treasury will improve the situation. Railroad earnings continue very favorable. Activity in the iron and steel trade is reported to be of great proportions.

ELECTRICAL SECURITIES FOR THE WEEK ENDING SEPTEMBER 1.

New York:	*Closing.*
Allis-Chalmers common	19
Allis-Chalmers preferred	46
Brooklyn Rapid Transit	76¾
Consolidated Gas	139½
General Electric	167
Interborough-Metropolitan common	37¾
Interborough-Metropolitan preferred	78
Kings County Electric	160
Mackay Companies (Postal Telegraph and Cables) common	73
Mackay Companies (Postal Telegraph and Cables) preferred	71
Manhattan Elevated	148
Metropolitan Street Railway	106
New York & New Jersey Telephone	125
Western Union	91½
Westinghouse Manufacturing Company	153

The directors of the General Electric Company have declared the regular quarterly dividend of 2 per cent, payable October 15 to stockholders of record September 15.

A regular quarterly dividend of 1 per cent on the preferred shares and a regular quarterly dividend of 1 per cent on the common shares of the Mackay Companies will be paid on October 1 to shareholders of record as they appear at the close of business September 15. The transfer books will be closed from September 17 to September 29, inclusive.

The Kings County Electric Light and Power Company has made application to the state commission of gas and electricity for consent to increase its capital from $8,200,000 to $10,000,000. The commission meets September 10 to consider the application.

Boston:	*Closing.*
American Telephone and Telegraph	133
Edison Electric Illuminating	239
Massachusetts Electric	69¾
New England Telephone	129
Western Telephone and Telegraph preferred	86

The annual report of the Edison Company, of Boston, for the year ended June 30 last showed 11.2 per cent earned on the $11,488,100 stock, against 9.4 per cent the previous year. The operations for the past fiscal year were by far the best in the history of the company. Two factors were responsible for the good statement for the year, namely the remarkable increase in new business and reduction in operating costs. Of the increase in gross earnings for the past fiscal year, amounting to $439,990, or 13 per cent larger than the previous year, there was saved for net earnings $174,678, making net figures 15 per cent larger than for the previous year. From the proceeds of the proposed 10 per cent increase in capital the company will be able to clean up its present large floating debt. The directors, however, are not expected to take action on the new stock issue for a couple of months.

Philadelphia:	*Closing.*
Electric Company of America	11
Electric Storage Battery common	72
Electric Storage Battery preferred	72
Philadelphia Electric	8⅝
Philadelphia Rapid Transit	28¾
United Gas Improvement	86⅜

United Gas Improvement, the company most directly affected by the failure of the gas lease extension and the consequent political upheaval in Philadelphia a year ago last spring, is almost the only company whose shares have recovered to any extent from the shock received at that time. Allowing for the value of the stock allotment, which United Gas Improvement stockholders have since received, the present price around 87⅜ is equivalent to the former price above 96, rights on, at which it sold earlier this year. Immediately after the failure of the gas lease proposition the prices went below 90. Union Traction also has moved to a somewhat higher plane. The guarantee is now 5 per cent as against 4 per cent per annum the past two years and the quotation is further affected by the approach of a still higher rate of dividend.

Chicago:	*Closing.*
Chicago Telephone	119
Chicago Edison Light	140
Metropolitan Elevated	66½
National Carbon common	85
National Carbon preferred	119
Union Traction common	5
Union Traction preferred	18

South Side Elevated's daily passenger traffic for August was 93,084, an increase of 7,796.

The Metropolitan Elevated's daily average of passengers carried for August was 123,512, an increase of 7,117.

Northwestern Elevated during August showed a daily average of 68,938 passengers, an increase of 4,238 daily.

PERSONAL MENTION.

MR. J. F. DAVIS, formerly connected with the Pittsburg organization of the Atlas Engine Works, Indianapolis, Ind., has been transferred to the company's offices at Chicago.

MR. C. V. MILLS, formerly general manager of the Chester Traction Company, has accepted a similar position with the Union Electric Construction Company, of Philadelphia.

MR. R. K. MICKEY, president of the Novelty Incandescent Lamp Company, St. Marys, Pa., and his wife, were visitors to Chicago during Monday, Tuesday and Wednesday of last week.

MR. NORMAN MARSHALL, president of the Marshall Electric Manufacturing Company, Boston, Mass., is spending his vacation on an automobile trip through the White Mountains and the Adirondacks.

MR. DONALD McDONALD, president of the Kentucky Heating Company, has been elected president of the Kentucky Electric Company. This company has secured the franchise for lighting the city of Louisville, Ky.

MR. J. N. COX has been appointed superintendent of the Nashville division of the Cumberland Telephone Company. Mr. Cox was general manager of the Gainsboro Telephone Company at Sparta, Tenn., for ten years and joined forces with the Cumberland Telephone Company last April.

MR. J. ALLEN HAINES, of Chicago, has been spending a few weeks in New York. Mr. Haines will hereafter represent the Stanley & Patterson Company, of New York, in the West, with headquarters at 324 Dearborn street.

MR. J. P. JOHNSTON, for several years past general sales manager for the Weber Steel Concrete Chimney Company, Chicago, Ill., has resigned to become sales manager of the water-tube boiler department of the Atlas Engine Works, Indianapolis, Ind., making his headquarters at Indianapolis.

MR. THOMAS L. PHILLIPS, who for some time has been employed by the Ontario Power Company, of Niagara Falls, Ontario, has been engaged as superintendent by the Genesee County Electric Light, Power and Gas Company, of Batavia, which is to distribute Niagara Power in this county.

MR. J. LESTER WOODBRIDGE, formerly engineer of the sales department of the Electric Storage Battery Company, Philadelphia, Pa., has been appointed chief engineer of that company, succeeding J. B. Entz, who has resigned to accept the position of vice-president of the Electric Vehicle Company, of Hartford, Ct.

MR. S. M. KENNEDY, general agent of the Edison Electric Company, Los Angeles, Cal., has been ill at his home at Alhambra, Cal., for several weeks as the result of a railway accident. His many friends in the field will be glad to learn that he is now convalescing and expects to return to his duties at Los Angeles in a short time.

MR. JOSEPH G. RAY has been elected a director of the Woonsocket Electric Machine and Power Company. He succeeds his father, the late Edgar K. Ray. The new director is a man under thirty years of age, yet he is vice-president of one of the Woonsocket banks and the general manager of four large street-railway companies—namely, the Providence & Burrillville, the Columbian, the Woonsocket, and the Milford, Attleboro & Woonsocket—all of which are part of the Ray system, so-called, of street railways.

MR. W. H. WHITESIDE, president of the Allis-Chalmers Company, Milwaukee, returned on August 22 from a two months' combined business and pleasure tour of England, France, Germany and Switzerland. Mr. Whiteside inspected various large manufacturing industries of England and on the Continent. Among them he visited the plants of the leading English steam turbine builders whose American rights for building Parsons steam turbines for marine and land use are enjoyed by the Allis-Chalmers Company.

MR. CHARLES LAMBERT KINSLOE, of Lock Haven, Pa., has been elected assistant in the electrical engineering department of the Western University of Pennsylvania. Mr. Kinsloe graduated from the electrical engineering department of State College in 1903, with the degree of bachelor of science. He was employed by the Westinghouse Electric and Manufacturing Company at their works at Wilmerding for some time after graduating from college, and for the past two years has been engaged in experimental laboratory work in the engineering department of the Philadelphia Electric Company.

NEW INCORPORATIONS.

FLINT, MICH.—Oak Park Power Company. $60,000.

CLOVERDALE, ORE.—The Cloverdale Telephone Company. $2,000. Incorporators: Charles Ray, Charles P. Nelson and Merl Nelson.

INDIANAPOLIS, IND.—The Williams Telephone Company, Parke county. $200. Directors: James A. Taylor and James H. Adams.

SALEM, ORE.—Madras & Eastern Railway Company. Principal office, Prineville, Ore. $10,000. Incorporators: John W. Collins, L. B. Lafollett and Walter O'Neil.

HARRISBURG, PA.—Merchants and Farmers' Telephone Company, Cochranton; $5,000. Philadelphia, Pittsburg & Erie Telephone Company, Harrisburg; $10,000.

COLUMBUS, OHIO—The Dayton Street Railway Company, Dayton. $10,000. Incorporators: Dennis Dwyer, Albert Emmanuel, Charles Bosler, Samuel A. Price and Edward A. Fay.

COLUMBUS, OHIO—The Navarre Electric Light Company, Navarre, Stark county. $10,000. Incorporators: John W. Zinsmaster, George A. Myer, David A. Fisher, Peter Zinsmaster and Charles Fetters.

ALBANY, N. Y.—The Cooperstown & Northern Railway Company. To operate in Otsego county between Cooperstown, Springfield and East Springfield. $240,000. Directors: Sheldon A. Young, of East Springfield; Fred J. Maxted and Charles A. Stannard, of Springfield Centre.

PORTLAND, ME.—Salem Light, Heat and Power Company. Organized at Portland for the purpose of carrying on the business of generating and supplying electricity for various purposes. $100,000. Officers: president, W. DuBois Palver, of Salem Depot, N. H.; treasurer, Wallace W. Cole, of Salem Depot, N. H.

ATLANTA, GA.—Atlanta, Griffin & Macon Electric Railroad Company. To build and operate an interurban trolley line between Atlanta and Macon, Ga., passing through several populous towns. $100,000. Incorporators: N. P. Pratt, W. A. Wimbish, Clifford L. Anderson, Edwin P. Ansley, of Atlanta; W. J. Massee, J. T. Moore, Minter Wimberly, W. J. Kincaid, James M. Brawner, Seaton Grantland, of Macon; N. B. Drewery, of Griffin.

NEW PUBLICATIONS.

ACTUAL STATE OF THE ELECTRICAL INDUSTRIES—During the past two years a number of discussions have taken place before the Société d'Encouragement pour L'Industrie Nationale and the Société Française de Physique, upon the actual state of the electrical industries. These have been brought together and issued in pamphlet form by Gauthier-Villars, Paris.

A STUDY OF RESONANCE IN ANTENNÆ SYSTEMS FOR WIRELESS TELEGRAPHY—M. Camille Tissot has issued, in pamphlet form, his study of resonance in antennæ systems used in wireless telegraphy. This paper was originally printed in *Annales de Chimie et de Physique*, March and April, 1906.

REPORT OF THE COMMISSIONER OF EDUCATION— Vol. ii of the report of the commissioner of education for the year 1904 has been issued by the Department of the Interior, Washington, D. C. This volume describes the exhibits made during the World's Fair at St. Louis by the various colleges and universities in this country. It also gives statistics dealing with city school systems, universities, colleges and technical schools, agricultural and mechanical schools, professional education, normal schools, business schools, schools for nurses, etc. One chapter is given over to statistics of foreign universities and institutions of higher education.

TELEPHONE AND TELEGRAPH.

SPRINGFIELD, MASS.—The American Telephone and Telegraph Company has received a franchise to operate in Morningside.

CONWAY, MASS.—The Heath Telephone Company is extending its line to Whately. It will then connect with the Northampton line.

SCHENECTADY, N. Y.—The Hudson River Telephone Company has been extending its line from Schenectady along the Sacandaga road, a distance of nine miles.

OMAHA, NEB.—The Home Telephone Company, now known as the Gate City Telephone Company, has agreed to accept a thirty-five-year franchise from the city of Omaha.

SAN ANTONIO, TEX.—A new telephone system is being installed at Fort Sam, Houston. Instead of the old style of telephones, the automatic system will be put into use.

DELMONT, S. D.—A farmers' telephone company is erecting a line running twelve miles northwest of Delmont and connecting with the exchange there. A third line is contemplated, running northeast toward Parkston and Hillsdale.

NIAGARA FALLS, ONTARIO—The Stark Telephone, Light and Power Company, of Toronto, is asking the right to operate in Niagara Falls. It offers a free fire-alarm service, ten city telephones free, a house rate of $18 and an office rate of $36 per year. The company will put in an automatic system, have no party lines, and desires to use the city poles when practicable.

ST. JOSEPH, MO.—The Missouri & Kansas Telephone Company is extending its system of underground conduit, with a view of improving the service and removing poles from the streets. About 150 men are employed in this work, and the extensions are about one-third finished. Telephone poles are removed from the streets as rapidly as the underground conduits are laid. The size of the conduits varies from two inches to fourteen inches. There are about 400 pairs of wires in each cable.

IOLA, KAN.—The Missouri & Kansas Telephone Company has decided to accept the terms of the recent ordinance passed by the city council, fixing the telephone rates at $2 per month for business telephones and $1.50 per month for residence telephones. The Missouri & Kansas Telephone Company at the time the ordinance was passed by the council made a strong effort to have the rate for business telephones increased to $2.50 per month, claiming that in view of the service furnished such a rate was not exorbitant. The city council, however, held out firmly for the $2 rate for business telephones, and passed the ordinance at that figure.

JOPLINE, MO.—At the last meeting of the Quaker Valley Mutual Telephone Company, L. K. Moeller addressed the company and stated that the business men of Galena and many of the private citizens were strongly in favor of having a mutual telephone service in the city that would give them the benefit of the farmers' mutual lines which at present surround the city. The Quaker Valley local was assured that if it would extend its line to Galena that there would be a mutual company organized in the city in the next few weeks. After some discussion the matter of moving to Galena was put to a vote which resulted in favor of the proposition.

ALBANY, N. Y.—Articles of incorporation of a new telephone company to operate in the southern part of Rensselaer county have been filed in the county clerk's office. It is called The Upper Hudson Telephone Company and has a capital stock of $10,000. According to the articles of incorporation Castleton is the home office of the company. Three routes are described. One is south from Castleton to Schodack Landing, Poelsburg and Muitzeskill, connecting with the Valatie line at Elm Grove. The second is east from Castleton to East Schodack, East Greenbush, Schodack Centre, Nassau Lake, Miller's Corners, Averill Park, West Sand Lake, Snyder's Corners, Alps and other small places intervening. The third runs between Coxsackie, Four-Mile Point and New Baltimore. The directors are: Andrew A. Gardenier, of Schodack Landing; Harvie McK. Curtis, of Coxsackie; Clifford C. Hastings, of West Sand Lake; Wakely Best, of Coxsackie; Philip S. Parks, of Muitzeskill; Alberti Baker, of Coxsackie, and Martin A. Springstead, of Castleton.

ELECTRIC LIGHTING.

SALT LAKE CITY, UTAH—The Shoshone Power Company is now erecting its poles in Davis county, preparatory to stringing its wires.

MILO, ME.—Fred W. Bolster has been awarded the contract to build the new power station for the Milo Electric Light and Power Company.

KUTZTOWN, PA.—At a recent special election it was decided to secure a $10,000 loan, to be used to increase the capacity of the municipal electric light plant.

ROME, N. Y.—The Rome municipal council has approved of the municipalization of the electric light plants and the establishment of a special plant owned by the city.

TERRELL, TEX.—The city of Terrell has voted nearly three to one in favor of the municipal ownership of the electric light plant, and bonds are to be issued to construct one.

NAPOLEONVILLE, LA.—At a meeting of the Napoleonville town council a committee was appointed by the mayor to look into the probable cost of an electric light plant for the town.

ELGIN, ILL.—An ordinance has been passed granting to the Elgin Merchants' Light Company a franchise for twenty years to operate a system for furnishing electric light, heat and power to local consumers.

DENVER, COL.—The receipts of the Ephrata electric light plant for July of the current year were $414.02, and the expenditures incurred in operating the plant during the same time were $106.21, leaving a net gain of $307.81.

CLAREMORE, I. T.—The Claremore council has taken over the electric light plant. The consideration was $28,000. This is the first move toward installing the $85,000 waterworks system recently voted, the bonds for which were sold to an Iowa corporation.

WILMINGTON, DEL.—It is announced that the Commercial Light, Heat and Power Company, which recently received a franchise in Wilmington, has been financed and will permanently organize and proceed to engage in business. The new company will transact an electric and gas lighting business.

DANIELSON, CT.—The borough of Danielson has entered into a contract with the People's Light and Power Company for twenty-two arc lights, at a price of $72 per lamp; and not less than sixty-four twenty-five-candle-power incandescent lamps, at $15 per lamp. The contract is to run for five years from September 1.

ONEIDA, N. Y.—The board of public works has awarded the contract for lighting Oneida to the Hudson Power and Electric Company for a period of five years. The new company will light the streets of Oneida for just about one-half of what the city has been paying, the new contract price being $37.50 per arc lamp per year.

COAL CREEK, TENN.—Preparations are being made and ground has been purchased for building an electric light plant at Coal Creek. W. M. Banks and D. C. Taylor, two of Coal Creek's most prominent business men, are the promoters. The boiler and dynamo will be purchased at an early date and will be installed as soon as they arrive.

CATSKILL, N. Y.—The new electric light station between Tannersville and Hunter burned to the ground on August 17. The plant furnished light to Tannersville, Hunter and Haines Falls, and its destruction leaves these towns in darkness. The cause of the fire is unknown. The plant was owned by New Yorkers and was partly insured.

IRON MOUNTAIN, MICH.—At the annual meeting of the stockholders of the Iron Mountain Electric Light and Power Company O. C. Davidson, John T. Jones, E. F. Brown, A. C. Cook, James H. Cundy, L. T. Sterling and George Irving were elected directors. The reports of the several officers were read and were of a very satisfactory nature.

SEATTLE, WASH.—L. S. Robe, mining engineer, and Wilson & Stackpole, Dawson lawyers, have applied for 60,000 inches of Twelve-Mile river water, a mile from the Yukon, for the purpose

of generating electricity for Alaska and Yukon territory. They promise to spend $100,000 this year and have their plant in operation two years after the grant is confirmed.

BERGEN, N. Y.—The Genesee Power Company has made a proposition to the Business Men's Association, of Bergen, to tap the Niagara, Lockport & Ontario Power Company's line at the West Shore, a mile north, and erect a $10,000 station and transformer, for the purpose of furnishing the village with power and light, provided that the company be guaranteed business to the amount of $5,000 a year.

DENVER, COL.—In accordance with the vote at the last election an ordinance was presented to the Denver board of supervisors authorizing a contract between the Denver Gas and Electric Company and the city of Denver, for ten years, whereby the city is to be furnished with arc lamps at the rate of $60 per lamp. Councilmen estimate that the new contract means a saving of over $36,000 a year to the city.

SPOKANE, WASH.—Active work has been commenced on the new Inland Empire power plant below Nine-Mile bridge. An immense coffer dam will be placed across the river at this point. The contract for the building of the plant, which is planned eventually to develop 20,000 horse-power, has been let to Sanderson & Porter, and the cost is estimated at about $850,000. All the material for construction has been delivered.

VERSAILLES, MO.—An election was held to determine whether or not the city should set aside its present electric light system and buy current from a company to be organized and furnish light through a cable from the Gravois, a stream ten miles distant, and the proposition carried by 218 to 12. The present electric light system has been in use two years, but it is proposed to furnish the city with cheaper lights from the water power.

FREMONT, NEB.—An effort will be made to complete the new $50,000 municipal light station this year. The city council at its last meeting decided to push the work. A committee was appointed to secure options on sites and the clerk and mayor were ordered to advertise for bids for bonds. The plant will be located between F street and Military avenue, close to the railroad tracks. One of the objects in moving instead of remodeling the present plant is to get close to the railroads so the cost of hauling machinery and coal will be saved.

COVINGTON, KY.—Two resolutions, looking to the building of a municipal electric light plant, have been passed by the board of council. They were offered by Mr. Nordmeyer, and on his motion they were passed under a suspension of the rules. One directs the city clerk to advertise for bids for erecting an electric light plant as provided for in the plans and specifications prepared by Owen Ford, of St. Louis, Mo. The other directed the city clerk to advertise for proposals for superintending the erection of the plant and for estimating the cost of operating and maintaining the plant.

VANCOUVER, B. C.—The plans of the Stave Lake Power Company, now building a dam on the Stave river for the conservation of the waters of that stream for use in the generation of electrical energy, have been amplified so that instead of having a maximum of 30,000 horse-power there will be available 40,000 during the driest season. The total area to be flooded will be about sixty square miles. Survey parties are now at Stave river and Stave lake determining the exact area which will be flooded. The company has determined to proceed with dam construction during the coming winter.

NOBLESVILLE, IND.—T. C. McReynolds, of Kokomo, manager of the Noblesville Heat, Light and Power Company, reports that work will begin immediately on the company's new power-house. It will be located immediately west of the waterworks power-house on the company's own ground and will be a one-story building, 100 by 75 feet. The foundation will be of concrete and cement and the remainder of the structure brick and stone. The estimated cost of the building ranges from $5,000 to $8,000. When it is equipped with all the new machinery which the company has ordered the plant will represent an investment of $25,000.

BELLEVUE, PA.—The Bellevue, Allegheny county, borough council voted a five-year lighting contract to the Ohio Valley Light Company, over the veto of Burgess Edward S. Means, Sr. The company now has a contract which does not expire until December, 1907, but to forestall efforts to bring competition for light into the borough the old company made a reduction in its old contract on condition that it be given a new one. The Pennsylvania Light, Heat and Power Company had offered to make a contract at a price $5 less a year for each lamp. Petitions are to be circulated asking Burgess Means to refuse to execute this new contract, so that if the present company wishes to enforce the resolution overriding the veto it may be necessary to take the matter into court on mandamus proceedings.

ST. LOUIS, MO.—Two lighting contracts for the illumination of city buildings were let at a meeting of the St. Louis board of public improvements. The Union Electric Light and Power Company got the contract for lighting south of Washington avenue, and the Laclede Power Company secured the lighting contract north of Washington avenue. Neither of the companies had competition, and despite this fact the Union Electric Light and Power Company put in a bid lower than the one of last year. This year's contract will save the city $1,100. The bid of the Union Electric Light and Power Company for the district south of Washington avenue was four and one-half cents per kilowatt-hour. Last year's bid was five cents. The bid of the Laclede Power Company was five and one-half cents per kilowatt-hour, this bid being the same as last year's.

CLINTON, MASS.—Papers have been signed conveying eight acres of land belonging to H. W. Atherton, of Still River, to the Boston Light, Heat and Power Company. Mr. Atherton and F. L. Fullam, the latter superintendent of the gas and electric light plants owned by the company in Clinton, signed the deeds. The transfer of the land in Still River is a big step in the plans of the Boston Light, Heat and Power Company for the gas and electric plants which the corporation intends to establish in Still River for furnishing light to Leominster, Groton, Harvard and, eventually, Lancaster and Clinton. The corporation, within the past two months, has acquired the farm of Royal Cheney and also land owned by the Boston Paving Company. The acquisition of Still River real estate gives the corporation about all the land needed for carrying out the plans which have been made to date.

BALTIMORE, MD.—The Consolidated Gas, Electric Light and Power Company has awarded a contract for the building of an engine room as an addition to the plant at Westport. The construction will be of ferro-concrete, similar to that of the plant. The building was originally designed to include this boiler house, when the necessities of the company required it. The first installation arranged was for five generators of 2,000 kilowatts each. Four were installed and partly operated, when it was found the company needed more power. The fifth generator, instead of having a capacity of 2,000 kilowatts, was contracted for on the basis of supplying 5,000 kilowatts. The new boiler room, which will be built on the north side of the structure, and of which it will become a part, will contain an engine of 7,500 horse-power. The building will be made sufficiently large to take care of any future expansion in the boiler capacity of the company.

ALEXANDRIA, VA.—The state corporation commission of Virginia, at Richmond, has granted a charter to the Alexandria Electric Light Company, which is to construct and operate a plant in the city of Alexandria to furnish electricity for light, heat and power in Alexandria, Alexandria county, and Fairfax county. The capital stock is $100,000, and C. C. Carlin is the local attorney. The officers are: W. L. Mathues, of Media, Pa., president; J. L. Rigby, of Media, Pa., vice-president, and E. E. Mandeville, of Philadelphia, secretary and treasurer. The officers and H. J. Makiver and F. L. Blest, both of Philadelphia, compose the board of directors. Mayor Fred J. Paff, of Alexandria, signed the contract with the Alexandria Electric Light Company for the lease of the electric light franchise for a term of thirty years. Agents of the company have examined several proposed sites for the location of the plant and have expressed themselves as greatly pleased with the conditions in the city. Although no location has been definitely decided upon, the company has several under advisement, and it is thought that they will shortly decide upon the site. The work of constructing the plant, which will cost about $75,000, will soon be commenced.

INDUSTRIAL ITEMS.

THE LOCKE INSULATOR MANUFACTURING COMPANY, Victor, N. Y., in engineering sheet No. 6 describes and illustrates storm tests of insulators. This is an interesting dissertation which will be read with profit by any one interested in this subject.

THE GOODWIN & KINTZ COMPANY, Winsted, Ct., makers of fine metal goods, has ready a new line of gas and electric portables and will send its handsome catalogue illustrating and describing the devices upon request. This catalogue shows a wide range of choice and is replete with examples of high grade and artistic fixtures.

THE NORTHERN ELECTRIC AND MACHINE COMPANY, 22 Brooklyn avenue, Brooklyn, N. Y., announces its facilities for effecting prompt shipments of line construction material, creosoted and plain cross-arms, locust pins, etc. Where delivery, quality and price are concerned, R. B. Fernhead, buyer for the company, announces that he is in a position to assure excellent facilities.

THE ATLAS ENGINE WORKS, Indianapolis, Ind., whose Chicago sales offices have for several years been in the Fisher Building, will, upon the completion of the new Fisher Building in November, increase its present quarters by the addition of several larger offices. Mr. Frank H. Baker, connected with the Atlas company for over twenty years, will continue at the head of its Chicago organizations.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is sending out a circular on "D. & W." enclosed fuses, for which the company is the general western agent. This circular contains an illustration of the D. & W. Fuse Company's new office and factories, which are said to be the most complete and largest enclosed fuse factories in the world. The circular will be sent to any one interested upon request.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburgh, Pa., is in receipt of a letter from the Greene Electric Light, Power and Manufacturing Company, Ashburnham, Mass., containing the following: "I am very much pleased with the performance of the 100-light transformer. It carried 150 lights four hours a day for four months. I examined it frequently with a full load of 150 lights, but could detect no rise in temperature above normal. It did not get warm to the hand. I have one 400-lighter which has 600 lights on it at times and shows no signs of heating."

THE EXCELLO ARC LAMP COMPANY, New York city, announces that an order for eighty-one lamps has recently been placed with the British representative of the company for lighting Oxford street, London. This order was the outcome of elaborate trials with the best makes of lamps. The British office of the company has also, among others, the following municipal street-lighting contracts at hand: Borough of Islington, 250 additional lamps; Southport, seventy-one lamps on constant current, 2,000 volts (this is in addition to the first installation of thirty lamps); Stepney, sixty lamps; Greenock, fifty-three lamps. The Excello arc lamp is also used in many prominent installations throughout Great Britain and in municipal street-lighting systems in Melbourne and Sydney, Australia; Johannesburg, South Africa; Buenos Aires, South America; Yokohama, Japan, and several other important European cities.

THE PHOENIX GLASS COMPANY, New York city, is in receipt of many commendations upon the stability of the Phoenix inner globes. Quite recently the Valley Electric Company, New Brighton, Pa., in commenting on its results with inner and outer arc lamp globes, stated that with one installation of fifty-one Fort Wayne form "C" direct-current series arc lamps at Bedford, Pa., the lights had been burning from dark to daylight from July, 1905, until May, 1906, with but three outer and five inner globe renewals. One outer and three inner globes were broken maliciously through the lamps being unhooked and dropped into the street, and the carbon setter was responsible for the breaking of two of the inner globes. The Valley company also states that it is now on its second thousand box of carbons, showing that there is a very small consumption of carbon, due to the globes fitting the gas cap perfectly.

THE MARINE ENGINE AND MACHINE COMPANY, 126 Liberty street, New York city, through its elevator department, announces the following list of recent contracts: Oliver Estate, Pittsburg, Pa.; Russell House, Detroit, Mich.; Brown Shoe Company, St. Louis, Mo.; Seligman Building, New York city; Brooklyn Eye and Ear Hospital, Brooklyn, N. Y.; Brunswick Site Building, New York city; Flatbush terminal, Long Island Railroad, Brooklyn, N. Y.; Bemis Brothers Bag Company, Manitoba; Alpha Delta Phi Club, New York city; Western Electric Company, New York city; B. T. Babbitt Company, New York city; Brooklyn Rapid Transit Company, Brooklyn, N. Y.; Hartford Building, New York city; Automobile Club of America, New York city; Gulf Bag Company, New Orleans, La., Brown Building, Toronto, Ontario; Blackstone Building, St. Louis, Mo. The elevator sales department has been augmented by the opening of a Chicago office in the Marquette Building and a St. Louis office in the Chemical Building.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has published a handsome booklet entitled "Through Frisco's Furnace." This booklet gives a series of reproductions of buildings taken after the earthquake and fire which recently devastated the larger portion of the business and residential section of San Francisco, Cal. The remarkable resistance of the steel and granite structures to both the earthquake and fire demonstrates the correctness of the views of the American engineers and architects who had pinned their faith on the durability of these structures. The company has made an examination of the protective action of Dixon's silica graphite paint wherever it was used on the steelwork of high buildings in San Francisco. The manner in which this silica graphite paint preserved the maximum strength of the steelwork of high buildings in San Francisco is well shown in the reports and photographs exhibited in this booklet. This exhibition is really remarkable and should be studied by every one interested in the protection of steel structures by artificial coatings in the form of paint.

Directory of Electrical and Allied Engineering and Scientific Societies.

(Published in the Second Issue of Each Month.)

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Secretary, L. O. Howard, Cosmos Club, Washington, D. C.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Secretary, Dr. C. E. Skinner, New Haven, Ct.

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, S. S. Sadtler, 59 South Tenth street, Philadelphia. Next meeting, New York city, October 8 and 9, 1906.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Secretary, Ralph W. Pope, 95 Liberty street, New York. Meetings, fourth Friday of each month.

AMERICAN MATHEMATICAL SOCIETY. Secretary, F. N. Cole, 50 West 116th street, New York city.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Secretary, J. W. Taylor, Old Colony Building, Chicago, Ill.

AMERICAN ROENTGEN RAY SOCIETY. Secretary, Dr. G. C. Johnston, 514 Bijou Building, Pittsburg, Pa.

AMERICAN SOCIETY FOR TESTING MATERIALS. Secretary, Professor Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Secretary, Calvin W. Rice, 12 West Thirty-first street, New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Secretary, G. W. Tillson, Municipal Building, Brooklyn, N. Y. Next meeting, Birmingham, Ala., October 2-5, 1906.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION. Secretary, B. V. Swenson, 60 Wall street, New York. Annual meeting, Columbus, Ohio, October 15-20, 1906.

AMERICAN STREET AND INTERURBAN RAILWAY ENGINEERING ASSOCIATION. Secretary, S. W. Mower, 12 Woodward

avenue, Detroit, Mich. Annual meeting, Columbus, Ohio, October 15-19.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, George R. Stetson, New Bedford, Mass. Annual meeting, Hotel Frontenac, St. Lawrence River, held this week.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Secretary, P. W. Drew, Milwaukee, Wis. Annual meeting, Atlantic City, N. J., June 19, 1907.

ASSOCIATION OF ELECTRIC LIGHTING ENGINEERS OF NEW ENGLAND. Secretary, Welles E. Holmes, 308 Washington street, Newton, Mass. Annual meetings held in Boston on third Wednesday in March.

CALIFORNIA INDEPENDENT TELEPHONE ASSOCIATION. Secretary, P. T. Whittier, Spencer, Cal.

CANADIAN ELECTRICAL ASSOCIATION. Secretary, T. S. Young, Toronto, Ontario.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION. Secretary, George B. Tripp, Colorado Springs, Col. Next meeting, Denver, Col., September 18, 19 and 20, 1906.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Secretary, E. W. Poole, Bridgeport, Ct. Annual meeting in November, 1906.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Secretary, J. I. Lyle, 39 Cortlandt street, New York.

ELECTRIC CLUB OF CLEVELAND. Secretary, George L. Crosby, 1200 Schofield Building, Cleveland, Ohio.

ELECTRICAL CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, John P. Faure, 77 Water street, Ossining, N. Y.

ELECTRIC CONTRACTORS' ASSOCIATION OF STATE OF MISSOURI. Secretary, Charles J. Sutter, 1220 Pine street, St. Louis, Mo.

ELECTRICAL SALESMEN'S ASSOCIATION. Secretary-Treasurer, George H. Erich, 401 Monadnock Block, Chicago. Next annual meeting, Chicago, January, 1907.

ELECTRICAL TRADES ASSOCIATION OF CHICAGO—Secretary, Frederic P. Vose, Marquette Building, Chicago. Next meeting, Chicago, November 1, 1906.

ELECTRICAL TRADES ASSOCIATION OF PHILADELPHIA. Secretary, E. A. Symmes, 810 Drexel Building, Philadelphia, Pa. Meetings, second and fourth Thursdays each month.

ELECTRICAL TRADES ASSOCIATION OF CANADA. Secretary, William R. Stavely, Royal Insurance Building, Montreal, Canada. Next annual meeting, January 14, 1907.

ELECTRICAL TRADES ASSOCIATION OF THE PACIFIC COAST. Secretary, Albert H. Elliot, Claus Spreckels Building, San Francisco, Cal. Monthly meetings, San Francisco, first Thursday of each month.

ELECTRICAL TRADES SOCIETY OF NEW YORK (Member National Electrical Trades Association). Secretary, Franz Neilson, 80 Wall street, New York. Board of Directors meets second Friday of each month.

EMPIRE STATE GAS AND ELECTRICAL ASSOCIATION. Secretary, Rolland A. Davidson, 58 William street, New York city, N. Y. Annual meeting, New York city, October 12, 1906.

ILLINOIS STATE ELECTRICAL ASSOCIATION. Secretary, H. E. Chubbuck, La Salle, Ill. Next meeting, Springfield, Ill., September 19 and 20.

ILLUMINATING ENGINEERING SOCIETY. Secretary. Dr. Arthur H. Elliot, 4 Irving place, New York. Meetings in New York, second Friday of each month.

INDEPENDENT TELEPHONE ASSOCIATION OF SOUTHERN INDIANA. Secretary, E. W. Landgrebe, Huntingburg, Ind.

INDIANA ELECTRIC RAILWAY ASSOCIATION. Secretary, P. H. White, Indianapolis, Ind. Monthly meetings, second Tuesday of each month.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, Frank P. Foster, Corning, N. Y. Next meeting, Norfolk, Va.

INTERNATIONAL INDEPENDENT TELEPHONE ASSOCIATION. Secretary, A. L. Tetu, Nashville, Tenn.; assistant secretary, J. A. Harney, Electric Building, Cleveland, Ohio.

IOWA ELECTRICAL ASSOCIATION. Secretary, L. B. Spinney, Iowa State College, Ames, Iowa.

IOWA STREET AND INTERURBAN ASSOCIATION. Secretary, L. D. Mathes, Dubuque, Iowa.

IOWA TELEPHONE ASSOCIATION. Secretary, C. C. Deering, Boone, Iowa.

KANSAS GAS, WATER AND ELECTRIC LIGHT ASSOCIATION. Secretary, James D. Nicholson, Newton, Kan. Next meeting, Lawrence, Kan., October, 1906.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION. Secretary, James Maret, Mount Vernon, Ky. Regular meeting, second Tuesday in October each year.

MAINE STREET RAILWAY ASSOCIATION. Secretary, E. A. Newman, 471 Congress street, Portland, Me.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Secretary, Charles S. Clark, 70 Kilby street, Boston, Mass. Meets second Wednesday of each month, except July and August.

MICHIGAN ELECTRIC ASSOCIATION. Secretary, A. C. Marshall, Port Huron, Mich. Next meeting, October 16, 1906.

MISSOURI INDEPENDENT TELEPHONE ASSOCIATION. Secretary, James F. Barnett.

NATIONAL ARM, PIN AND BRACKET ASSOCIATION. Secretary, J. B. Magers, Madison, Ind.

NATIONAL ELECTRICAL TRADES ASSOCIATION. Secretary, Fred P. Vose, 1343 Marquette Building, Chicago.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton. 94 Genesee street, Utica, N. Y. Next meeting, New York city, 1907.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Secretary, W. C. L. Eglin, 136 Liberty street, New York city.

NEW ENGLAND ELECTRICAL TRADES ASSOCIATION. Secretary, Alton F. Tupper, 84 State street, Boston, Mass.

NEW ENGLAND STREET RAILWAY CLUB. Secretary, John J. Lane, 12 Pearl street, Boston, Mass. Meets last Thursday of each month.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, 114 Liberty street, New York.

NEW YORK STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, T. S. Lane, 536 Ellicott square, Buffalo, N. Y.

NORTHWESTERN ELECTRICAL ASSOCIATION. Secretary, B. C. Adams, Madison, Wis.

OHIO ELECTRIC LIGHT ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio.

OHIO INDEPENDENT TELEPHONE ASSOCIATION. Secretary, Ralph Reamer, Portsmouth, Ohio.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Secretary, F. W. Bullard, Cleveland, Ohio.

OHIO STREET RAILWAY ASSOCIATION. Secretary, Charles Currie, Akron, Ohio.

OLD TIME TELEGRAPHERS AND HISTORICAL ASSOCIATION. Secretary, John Brant, 195 Broadway, New York. Next meeting, Washington, D. C., October 9, 10 and 11, 1906.

ORDER OF THE REJUVENATED SONS OF JOVE. C. B. Roulet, Mercury, Dallas, Tex.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Secretary, Samuel G. Reed, Portland, Ore.

PENNSYLVANIA STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, H. E. Bradley, 135 South Second street, Philadelphia, Pa.

PENNSYLVANIA STATE STREET RAILWAY ASSOCIATION. Secretary, Charles H. Smith, Lebanon, Pa.

PIKE'S PEAK POLYTECHNIC SOCIETY. Secretary, E. A. Sawyer, Colorado Springs, Col. Meetings second Saturday of each month.

RAILWAY SIGNAL ASSOCIATION. Secretary, H. S. Balliet, 337 Madison avenue, New York. Next meeting, Chicago, September 11. Annual meeting, Washington, D. C., October 16, 17 and 18.

SOUTHWESTERN GAS, ELECTRIC AND STREET RAILWAY ASSOCIATION. Secretary, T. H. Stuart, Waco, Tex.

STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK. Secretary, C. B. Fairchild, Jr., 114 Liberty street, New York.

UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION. Secretary Electrical Committee, C. M. Goddard, 55 Kilby street, Boston, Mass.

VERMONT AND NEW HAMPSHIRE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, G. W. Buzzell, St. Johnsbury, Vt.

VERMONT ELECTRICAL ASSOCIATION. Secretary, C. C. Wells, Middlebury Electrical Light Company, Middlebury, Vt.

WESTERN SOCIETY OF ENGINEERS (Electrical Section). Secretary, J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

DATES AHEAD.

American Electrochemical Society. New York city, October 8 or 9.

American Institute of Electrical Engineers. New York city, September 28.

American Society of Municipal Improvements. Birmingham, Ala., October 2-5.

American Street and Interurban Railway Engineering Association; American Street and Interurban Railway Association, Columbus, Ohio, October 15-19.

Colorado Electric Light, Power and Railway Association, Denver, Col., September 18, 19 and 20.

Empire State Gas and Electrical Association. New York city, October 12.

Old Time Telegraphers and Historical Society. Washington, D. C., October 9, 10 and 11.

Order of the Rejuvenated Sons of Jove. Niagara Falls, N. Y., September 11-14. Boston, Mass., September 20.

Railway Signal Association. Next meeting, Chicago, Great Northern Hotel, September 11. Annual meeting, Washington, D. C., New Willard, October 16, 17 and 18.

Record of Electrical Patents.

Week of August 28.

829,381. ELECTRIC BELL. Sidney A. Beyland, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio. Filed April 22, 1904. The gongs are provided with supports, allowing a continuous path of adjustment.

829,390. TROLLEY HARP. Benjamin L. Dresser, Uxbridge, Mass. Filed September 14, 1905. Adjustable fastenings permit easy removal of the axle and spring catches for attaching the harp to the pole.

829,403. FINGER-CONTACT FOR ELECTRIC CONTROLLERS. Francis E. Imeson, Thornaby-on-Tees, England. Filed April 3, 1906. A contact tipped with an adjustable roller.

829,410. TELEPHONE DESK STAND. Ray H. Manson, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio. Filed February 28, 1905. A detachable support is mounted within the standard.

829,416. THIRD-RAIL INSULATOR. John J. McGill, Chicago, Ill., assignor of one-half to Frank J. Guernsey, Chicago, Ill. Filed December 14, 1905. An insulating pedestal, fitted base and clamping cap.

829,419. TELEPHONE EXCHANGE. Nils E. Norstrom, Chicago, Ill., assignor, by direct and mesne assignments, of one-half to John Anderson, Salina, Kan., and one-sixth to Globe Automatic Telephone Company, Chicago, Ill. Original application filed May 31, 1900. Divided and this application filed November 14, 1903. A selecting device for automatic telephones, the selection being made by the movement of a slider over a series of contacts.

829,421. ELECTRIC RELEASE MECHANISM. Jack Ochs, Texarkana, Tex. Filed February 27, 1906. An electromagnetic releasing gear.

829,429. SELECTIVE SYSTEM. Sylvanus A. Reed, New York, N. Y. Filed March 13, 1903. A number of parallel circuits are arranged so that each one may be actuated by a definite current strength.

829,447. METHOD OF PRODUCING AND UTILIZING UNDAMPED OR SUSTAINED ELECTRICAL OSCILLATIONS. Frederick K. Vreeland, Montclair, N. J., assignor to Wireless Telegraph Exploitation Company, New York, N. Y. Filed February 28, 1905. A discharge within a vapor-containing vessel is made oscillating by means of an alternating-current magnet.

829,469. PARLOR AND SLEEPING CAR HAVING ELECTRICALLY CONTROLLED BERTHS. Louie J. Harris, New York, N. Y. Filed May 23, 1906. The berths are concealed below the floor and raised into position by a motor.

829,511. ELECTROMAGNETIC MECHANISM FOR MUSICAL INSTRUMENTS. George H. Davis, New York, N. Y. Filed November 16, 1900. A solenoid having two windings, one of which throws a plunger, the other comes into action to withdraw it at the end of the stroke.

829,535. TELEPHONE WALL SET. Ray H. Manson, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio. Filed February 28, 1905. The set comprises a hollow base and cover hinged thereto, the necessary parts being placed within the base.

829,539. FINISHING ELECTRIC LAMP BULBS. George P. McDonnell, St. Louis, Mo., assignor to American Electric Company, East Orange, N. J. Filed September 1, 1905. The lamp is caused to rotate while a flame heats the sealed tip, which is allowed to sink within the lines of the bulb.

829,545. SPARKING PLUG. Charles E. Ross, Crafton, Pa. Filed July 9, 1904. A hollow conducting-casing, containing a core of non-conducting material through which passes an adjustable electrode.

829,557. MOTOR SUSPENSION. John E. Webster, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Filed January 3, 1906. The motor, mounted pivotally upon the axle, has a projection by means of which a compressed spring exerts a downward pressure upon it.

829,568. INCANDESCENT LAMP FILAMENT AND METHOD OF MAKING THE SAME. Jean M. Canello, Paris, France. Filed August 30, 1904. The filament consists of a rare earth oxide core, a continuous conducting coating of the metal ruthenium and an outer coating of thorium oxide.

829,570. MAGNETIC DOLLY BAR. Edward G. Caughey, Huntington, W. Va. Filed November 20, 1905. An electromagnet, the poles of which are brought close together so as to hold the head of a rivet.

829,572. TRANSFORMER. Frank Conrad, Edgewood Park, Pa., assignor to Westinghouse Electric and Manufacturing Company. Filed January 20, 1904. A transformer core is provided with two magnetic circuits of different dimensions, one of which is unsaturated and of high reluctance, the other saturated and of low reluctance. Coils are placed upon the two cores.

829,578. ANCHOR FOR GUY WIRES. Claude D. Enochs, La Crosse, Wis. Filed July 17, 1905. A shaft is provided with wings which are forced out at an angle when it has rotated after being driven into the ground.

829,606. RAILWAY SIGNAL. Robert J. Sheehy, New York, N. Y. Filed May 5, 1903. Renewed January 22, 1906. An electromagnet is placed at each end of a track block, which, by means of local signal loops, produces a signal on the train.

829,628. SELF-RESTORING SIGNALING DEVICE. Henry P. Clausen, Chicago, Ill., assignor to American Electric Telephone Company. Filed April 1, 1906. A pair of electromagnets placed so that one operates the signal, the other restores it to its normal position.

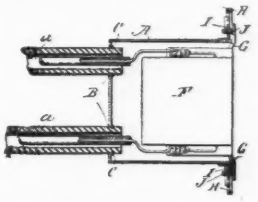
829,641. TROLLEY HARP. David J. Etly, Pittsburg, Pa. Filed December 13, 1905. Circular guard-plates are placed on each side of the wheel, projecting beyond its periphery. The plates are movable in respect to the harp.

829,643. STORAGE BATTERY. George A. Ford, Cleveland, Ohio, assignor to Harriet S. Ford, Cleveland, Ohio. Filed December 22, 1905. The units consist of trays made of infrangible absorbent material with upturned marginal edges and an inclined bottom.

829,644. WALL OR SWITCH BOX. Benjamin H. Glover, Buffalo, N. Y., assignor to Chicago Fuse Wire and Manufacturing Company, Chicago, Ill. Filed August 28, 1903. A box provided with ears for engaging the conduits and holding them in place.

829,646. INSULATOR. Walter T. Goddard, Victor, N. Y., assignor to Locke Insulator Manufacturing Company, Victor, N. Y. Filed January 7, 1905. A cap is provided for the insulators which attaches to its top and has a separate conductor seat.

829,724. TELEPHONE EXCHANGE APPARATUS. Frank R. McBerty, Evanston, Ill., assignor to Western Electric Company, Chicago, Ill. Filed August 2, 1902. A magnet is provided in each side of the metallic circuit for operating at will either one or two signals.



829,644. WALL OR SWITCH BOX.

829,726. TARGET-ILLUMINATING DEVICE FOR FIREARMS. Douglass McIntosh, New Glasgow, Canada, assignor to Frederick Johnson, Montreal, Canada. Filed September 1, 1905. A small lamp attached below the barrel lights a moment before firing, and is automatically extinguished immediately after.

829,736. INTERCOMMUNICATING TELEPHONE APPARATUS. Fred J. Ravlin and John Lofgren, Chicago, Ill., assignors of one-fourth to Arthur T. Averill and one-fourth to Glenn M. Averill, Cedar Rapids, Iowa. Filed January 15, 1906. Two members are provided, one rotatable by hand, which movement causes the other to follow and make a series of contacts.

829,774. TIME SWITCH. Henry Geisenhöner, Schenectady, N. Y., assignor to General Electric Company. Filed August 24, 1905. A receptacle held in normally one position by a spring contains mercury, which, when rotated against the spring, completes an electric circuit and is held in this position electrically. It returns to its normal position after the circuit is broken.

829,780. TRANSFORMER. Walter A. Hall, Lynn, Mass., assignor to General Electric Company. Filed May 12, 1904. A hollow rectangular iron core providing a single magnetic circuit, arranged so as to provide greater space between the coils on one side of the leg than on the other.

829,783. BLOCK SIGNAL SYSTEM. Max R. Hanna, Schenectady, N. Y., assignor to General Electric Company. Filed March 10, 1905. A signal system for alternating-current railways which employ the rails as return conductors; relays operating signals are actuated by direct currents.

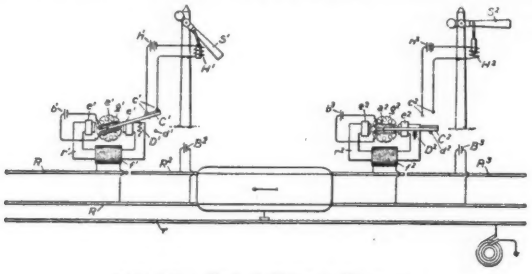
829,785. ELECTRIC SWITCH. Edward M. Hewlett and Theodore E. Button, Schenectady, N. Y., assignors to General Electric Company. Filed February 7, 1902. A group of switches closed one at a time, through a number of electric clutches, by an electric motor.

829,787. SPACE TELEGRAPHY. William S. Hogg, Washington, D. C., assignor to Overland and Marine Telegraph Company, New York, N. Y. Filed November 26, 1904. Two circuits are connected with the aerial, one attuned to the frequency to which the receiver responds, the other attuned for interfering waves.

829,790. APPARATUS FOR OZONIZING ATMOSPHERIC AIR. Edward L. Joseph, London, England. Filed December 12, 1905. An electric discharge takes place between electrodes separated by dielectrics, while air is circulated through the device.

829,794. CONTROLLER. Hermann Lemp, Lynn, Mass., assignor to General Electric Company. Filed December 18, 1905. Two braking positions are provided, one for forward and the other for reverse braking. A movable stop brings the contact member to rest in one or the other braking position.

829,799. COLLECTOR RING. Jakob E. Noeggerath, Schenectady, N. Y., assignor to General Electric Company. Filed September 22, 1905. The collector consists of parallel rings engaging one in the other, but separated by air spaces.



829,783. BLOCK SIGNAL SYSTEM.

829,806. FIXTURE SWITCH. Howard R. Sargent, Schenectady, N. Y., assignor to General Electric Company. Filed December 1, 1902. A rotatable switch which, by means of an M-shaped cam, causes quick opening or closing of the circuit.

829,808. ELECTRICAL WATER HEATER. Frederic F. Shipp, St. Louis, Mo., assignor to Electrical Heating and Manufacturing Company, St. Louis, Mo. Filed September 12, 1904. A non-conducting radiating body is pierced with parallel ducts through which the conducting heating body is threaded.

829,810. TEMPERATURE CONTROLLING APPARATUS. John H. Swan, Chicago, Ill. Filed January 20, 1904. A valve controlled by means of pressure set up in fluid heated electrically, the heating circuit being controlled by the thermostat.

829,812. TELEPHONE DISINFECTOR. Nelson J. Tubbs, Louisville, Ky., assignor of one-fourth to Hardin Collings, one-eighth to Frank C. Carpenter, and one-eighth to Walter F. Jones, Louisville, Ky. Filed May 8, 1905. The disinfector is in the shape of a cup within which the receiver is placed when idle.

829,822. TRACKLESS TROLLEY. Montraville M. Wood, Schenectady, N. Y., assignor to General Electric Company. Filed February 23, 1905. The running trolley which is carried on two parallel conductors is easily detached from the car to facilitate the exchange of trolleys when the two cars meet.

829,826. VOLTAGE REGULATOR. Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. Filed March 10, 1905. A series transformer is connected in the circuit of an alternating-current motor of low power-factor. The secondary winding of the transformer is connected in shunt with the motor, lamps being placed in this circuit. An adjustable air-gap is provided in the magnetic circuit of the transformer.

829,827. POWER-TRANSMITTING MECHANISM. Edward H. Anderson, Schenectady, N. Y., assignor to General Electric Company. Filed April 9, 1904. A prime mover drives two dynamo-electric machines, mechanically connected, and provided with means for varying their electrical connections.

829,828. REVERSE-CURRENT CUTOUT. Leonard Andrews, Manchester, England, assignor to Stanley-G. I. Electric Manufacturing Company. Filed June 19, 1905. Two coils are provided, one series and one shunt, carried on different portions of one core. A magnetic shunt is provided for each portion of the core.

829,832. RAILWAY SWITCH LOCK. Robert A. Becker, Schenectady, N. Y., assignor to General Electric Company. Filed January 16, 1906. An electromagnet controlled from a distance holds the lock.

829,841. SWITCH-OPERATING MECHANISM. Theodore E. Button, Schenectady, N. Y., assignor to General Electric Company. Filed October 1, 1904. Energy for operating a switch a number of times is stored up in a spring by means of a motor.

829,842. KINETIC SOLENOID. Benjamin F. Carpenter, Roselle Park, N. J. Filed May 12, 1904. Renewed December 30, 1905. Two coils for setting up a reciprocating motion.

829,845. FLUID-PRESSURE SYSTEM. Fred B. Corey, Schenectady, N. Y., assignor to General Electric Company. Filed February 2, 1903. A system for operating a motor-controlling switch by means of fluid pressure.

829,849. TELEPHONE OR LIKE TRANSMITTER. Hahnemann A. Cutmore, London, England. Filed September 28, 1905. The mouthpiece of the receiver is perforated with a series of holes, and is provided with a conical chamber in which a perforated diaphragm supporting a cone is placed in front of the diaphragm proper.

829,850. LAMP SOCKET. John C. Dallam, Schenectady, N. Y., assignor to General Electric Company. Filed August 12, 1905. A method of constructing a lamp socket, the parts of which are securely held together by a rotation of one in reference to another.

829,860. MEANS FOR CONTROLLING ALTERNATING-CURRENT MOTORS. Friedrich Eichberg, Berlin, Germany, assignor to General Electric Company. Filed January 11, 1905. A system of controlling alternating-current commutating motors in which connections are provided for supplying current to brushes placed at right angles to the normal brushes.

829,864. SAFETY INDICATOR FOR ELEVATORS AND TRACTION CARS. Robert H. Gaylord, Pasadena, Cal. Filed September 29, 1905. An electrically operated indicator actuated by the car controller.

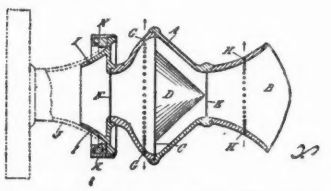
829,869. ADJUSTABLE ELECTROLIER. Alton Hopkins, Denver, Col. Filed May 15, 1905. A spring-actuated drum with suitable contacts which allows the height of the electrolier to be varied.

829,872. METHOD OF EFFECTING CHEMICAL ACTION IN GASES. Dimmitt R. Lovejoy, Niagara Falls, N. Y., assignor, by mesne assignments, to Atmospheric Products Company, Niagara Falls, N. Y. Filed March 22, 1901. A chemical combination is caused to take place by charging electrostatically molecules of different gases.

829,873. APPARATUS FOR SUBJECTING GASES TO HIGH-TENSION DISCHARGES. Dimmitt R. Lovejoy, Niagara Falls, N. Y., assignor to Atmospheric Products Company, Niagara Falls, N. Y. Filed May 29, 1902. Electric arcs are set up and broken by means of a rotating set of electrodes placed within a gas chamber.

829,874. METHOD OF EFFECTING THE COMBINATION OF GASES. Dimmitt R. Lovejoy, Niagara Falls, N. Y., assignor to Atmospheric Products Company, Niagara Falls, N. Y. Filed June 24, 1902. Renewed July 5, 1906. An electric arc is produced in air enriched with oxygen.

829,875. APPARATUS FOR EFFECTING CHEMICAL ACTION IN GASES. Dimmitt R. Lovejoy, Niagara Falls, N. Y., assignor to Atmospheric Products Company, Niagara Falls, N. Y. Filed July 19, 1902. Renewed July 5, 1906. Apparatus for carrying out the above process.



829,849. TELEPHONE OR LIKE TRANSMITTER.

829,876. PROCESS FOR EFFECTING CHEMICAL ACTION IN GASES. Dimmitt R. Lovejoy, Niagara Falls N. Y., assignor to Atmospheric Products Company, Niagara Falls, N. Y. Filed January 27, 1903. Renewed July 5, 1906.

829,877. APPARATUS FOR EFFECTING CHEMICAL ACTION IN GASES. Dimmitt R. Lovejoy, Niagara Falls, N. Y., assignor to Atmospheric Products Company, Niagara Falls, N. Y. Original application filed May 29, 1902. Divided and this application filed January 28, 1903. Renewed July 5, 1906. A combination of gases brought about by charging them electrostatically and subjecting them to action of the electric arc.

829,883. BINDING-POST. Chester Moody, Ellisville, Miss. Filed November 6, 1905. A perforated post over which is slipped a spring clip which holds firmly in contact the wire inserted through the post.

829,902. ILLUMINATED ADVERTISING SIGN. Frank H. Urry, London, England. Filed May 31, 1906. The sign screen is combined with a color screen and a dissolver having translucent and opaque portions.

829,905. ELECTRICAL RELAY. Harry M. Abernethy, Cleveland, Ohio, assignor to the American Railway Signal Company, Cleveland, Ohio. Filed July 8, 1905. A relay provided with a series of reversible carbon and platinum points and actuating electromagnets.

829,909. ELECTRIC BELL. Edward B. Craft, Chicago, Ill., assignor to Western Electric Company, Chicago, Ill. Filed October 21, 1904. A method of construction in which the core and return-plate pieces are punched out.

829,917. SWITCH. Francis K. Fassett, St. Louis, Mo., assignor, by mesne assignments, to William Maxwell Scott, Philadelphia, Pa. Filed April 27, 1904. A set of laminated contacts of an unequal length submerged in an insulation fluid, bridge across terminal blocks.

829,934. APPARATUS FOR THE PRODUCTION AND UTILIZATION OF UNDAMPED OR SUSTAINED ELECTRICAL OSCILLATIONS. Frederick K. Vreeland, Montclair, N. J., assignor to Wireless Telegraph Exploitation Company, New York, N. Y. Original application filed February 28, 1905. Divided and this application filed November 14, 1905. A vapor tube in which an electrical discharge takes place and is acted upon by an alternating magnetic field, so as to commutate the current within the tube.